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PALÆONTOLOGICAL BULLETINS,

Nos. 1-13.

BY EDWARD D. COPE, A. M.

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PALÆONTOLOGICAL BULLETIN.

BY EDWARD D. COPE.

Preliminary.

The papers included in the following numbers, are thirteen, as follows :

No. 1. Descriptions of some new Vertebrata from the Bridger Group of the Eocene. Published July 29th, 1872 ; reprinted in the Proceedings of the American Philosophical Society, early in January, 1873.

No. 2. Second account of new Vertebrata from the Bridger Eocene. Published August 3d, 1872 ; reprinted with the last.

No. 3. Third account of the New Vertebrata from the Bridger Eocene of Wyoming Territory. Published August 7th, 1872, reprinted with the last.

No. 4. On the existence of Dinosauria in the Transition Beds of Wyoming Territory. Published August 12th, 1872 ; reprinted with the last.

No. 5. Telegram describing extinct Proboscidians from Wyoming ; published August 19th, 1872 ; reprinted with the last.

No. 6. Notices of new Vertebrata from the upper waters of Bitter Creek. Published August 20th, 1872 ; reprinted with the last.

No. 7. Second notice of Extinct Vertebrates from Bitter Creek, Wyoming ; published August 22d, 1872 ; reprinted with the last.

No. 8. On a new Vertebrata genus from the northern part of the Tertiary Basin of Green River. Published October 12th, 1872 ; reprinted with the last.

No. 9. Descriptions of new Extinct Reptiles from the Upper Green River Eocene Basin, Wyoming. Published October 12th, 1872 ; reprinted with the last.

No. 10. Remarks on the Geology of Wyoming. Published December, 1872, in the Proceedings of the Academy of Natural Sciences, Philadelphia, for that month.

No. 11. On two new Perissodactyles, from the Bridger Eocene. Published January 31, 1873.

No. 12. On some extinct Mammals, obtained by Hayden's Geological Survey of 1872. Published March 8th 1873, not reprinted.

No. 13. On some of Prof. Marsh's criticisms. Published in the American Naturalist for April 1873 ; extended.

The preceding papers, from No. 1 to No. 9, are printed in the precise form in which they originally appeared, with an exception stated below, including all typographical errors. This is done because the edition of each as first issued was small, not exceeding 100 copies, and they will be

difficult to procure in consequence. Verification of the dates will be found in Bulletin No. 13, a point to be observed in connection with Nos. 4 and 5, which were issued without date attached, through the inadvertence of the printer. In the original issues of Nos. 3, 4, 7, and 12, the printers inserted at the head of each article "Read before the American Philosophical Society" without corresponding date; a statement untrue at that time, though the papers were all so read at a subsequent date. This insertion was not authorized by the author in any way, and is therefore erased at present, excepting in the case of No. 12, where it was inserted in spite of the especial request to have it omitted.

Philadelphia, July 16, 1873.

NO. 1.

DESCRIPTIONS OF SOME NEW VERTEBRATA FROM THE BRIDGER GROUP OF THE EOCENE.

BY E. D. COPE.

MESONYX OBTUSIDENS. Cope.

Represented by a large part of the skeleton of an individual of about the size of the wolf (*Canis lupus*). The lumbar vertebræ display the short acuminate, and anteriorly directed diapophyses, characteristic of carnivora, while the astragalus resembles that of the same group. The claws are flat and not curved. The molar teeth exhibit two principal lobes and a thin rudimental at one extremity. The middle lobe is a compressed cone, the posterior, a cutting edge, but medially placed, and less acute than in *Hyoenodon*, and the sectorial teeth of other carnivora, forming a less specialized cutting apparatus. The canines are well developed. A premolar is stout conic, with rudimental tubercle at base.

	M.
Length of a sectorial (crown)	0.018
Greatest width	.008
Elevation of crest	.006
Length of crown of a second	.015
Width	.0065
Elevation of middle lobe	.014
Length of crown of canine	.026
Diameter near base	.014

The number of the teeth cannot be determined, owing to the injured condition of the jaw bones. The enamel is entirely smooth.

Found on the bluffs of Cottonwood Creek, Wyoming.

TRIACODON ACULEATUS. Cope.

Established on two teeth of the molar and premolar series. The molar is subtriangular at the base of the crown, one side being convex; the opposite angle nearly right, and the two remaining sides flat. The crown is divided into three elevated trihedral cones, one at each angle. Their adjacent angles are acute, and the angle of union is fissured, like the same point in the sectorial tooth of a carnivora. The smaller lobes are of equal elevation, but the crown of one is expanded so as to be slightly spade-shaped. The enamel is smooth.

	M.
Elevation of highest cusp	0.009
" shorter "	.007
Long diameter base of crown	.006
" " " flat side	.005

The premolar is smaller, with shorter cusps, and one of the laterals reduced to a rudiment.

This species is near the *T. fallox* of Marsh, but the tooth he describes is narrower in proportion to its length, and has the anterior lobe little over half as high.

LOPHIOTHERIUM PYGMÆUM. Cope.

Represented by a portion of the right mandibular ramus with the penultimate and ante-penultimate molars in perfect preservation. These teeth present four cusps, of which the inner are crescentoid in section, the outer conic. They are all elevated, and the outer anterior is in both teeth compressed and bifid; it receives an oblique ridge from the inner posterior. Enamel smooth.

	Lines.
Length penultimate molar	2
Width	1.5
Depth of ramus at do	3

This is much the smallest of the genus, being about equal to the *Hyopsodus paulus L.* The penultimate molar in the nearest species, *L. ballardii,* Marsh, measures 3.2 lines in length.

ANOSTIRA TRIONYCHOIDES. Cope.

This species is about the size of our existing *Chrysemys fricta.* It differs from the *A. ornata,* Leidy, in various respects. Thus the sculpture of the costal bones is pit-like, as in many species of *Trionyx,* instead of striate-ridged. There is no keel on the pygal bone behind. The first marginal bone is longer, and does not exhibit the prominent shoulder seen in *A. ornata.* The marginal bones are not unlike those of that species, having central small tubercles, and radiating ridges. The species is not uncommon in the Bridger beds on Cottonwood Creek, Wyoming.

ANOSTIRA ŒDEMIA. Cope.

This species is nearly twice the size of the last. It is distinguished by its peculiar ornamentation. This consists of bosses or swollen portions of an oval shape, which stand transversely to the long axis of the body, from a quarter to a half an inch apart. They sometimes form short ridges, surface otherwise smooth. Locality same as the last species.

ANOSTIRA MOLOPINA. Cope.

This species is intermediate in size between the two last described. It is distinguished from both by its ornamentation. This consists of a delicate and rather scattered impressed punctuation on the costal bones. Across this extend oblique ribs extending in a diagonal direction outward near the extremities of the costals. The width of one of the costals is M. .023. The costals in this species display no suture for the marginals, and the extremity of the rib projects a very little.

TRIONYX CONCENTRICUS. Cope.

This species is not uncommon in the Bridger sandstone. It is well characterized by its sculpture, which is coarsely and distinctly pitted. Across the costal bones run parallel ribs, which enclose between them from three to one row of pits.

	M.
Width of a costal bone near the middle	.02
Thickness " " "	.003

Thus the carapace is thin. Besides being smaller than the *T. guttatus*, Leidy. This species differs in its longitudinal ribs.

TRIONYX THOMASII. Cope.

This tortoise is again distinguished from all those known by its sculpture, this being very delicate and obscure when compared with the thickness of the carapace. It consists of small tubercles of more or less elongate form, which may or may not emasculate; eight may be counted in M. .01. Width of a marginal costal, .02; thickness on suture, .0055. So in *T. concentrica*. The costals have very little curvature. The faintness of the ornamentation is a marked character.

Dedicated to my former teacher, Joseph Thomas, M.D., author of Lippincott's Biographical Gazetteer, the Pronouncing Gazetteer of the World, Baldwin's Gazetteer, and other important works.

Found with the *T. concentrica*, on Cottonwood Creek, Wyoming.

AXESTUS BYSSIMUS. Cope.

Genus et species novæ Trionyxchidarum.

This genus is represented by a species which is allied to *Trionyx*, but which differs in some important respects. The sternal bones are provided with an enamel stratum exterior to the usual dense layer of the bone, which is not sculptured. The post-abdominal bone has no sutural connections, but sends out tooth-like processes at its angles. The caudal vertebræ are procœlian, furnished with stout diapophyses and not very elongate; ball depressed, undivided. The cervical vertebræ are elongate and relatively very large. The claws are very large, and one at least flat and straight; the phalanges have broad trochlear surfaces, which indicate a moderate amount only of vertical movement. Both humeres and femur are curved and with extensive trochanters. The procoracoid and scapula are of equal lengths and the coracoid is much dilated distally.

Char. specif. The portions of plastron preserved are thin for the size of the animal, and all the bones are especially dense and smooth. The (?) post-abdominal has the free margins acute and serrulate. There is an (?) external gently convex edge with a long process extending backwards; and one long narrow one inwards. The enamel is white and is marked with decussating lines of osseous deposit, as in woven linen. This is not the result of wearing. The cervical vertebra is without spine; it is compressed in the middle and is without any pneumatic foramen.

	M.
Length cervical vertebra	.068
Diameter at middle	.020
" end	.035
" caudal do. at ball	,010
Length " "	.023
" of an ungueal phalange	.043
Proximal depth do.	.013
Length post-abdominal (broken)	.180
Width do	.120

Locality of the last.

Baena hebraica. Cope.

Established on a large and nearly complete fossilized tortoise, which acks the posterior lobe of the plastron, and a corresponding part of the carapace. The component elements are coössified.

The costal scuta are very wide, excepting the first pair, whose posterior margin is sigmoidally flexed. The anterior vertebral is concave behind, and has convex lateral margins. The marginal scuta in front are very narrow, but the fourth on each side is suddenly widened in front to meet the suture between the first and second costal scuta. The sutures are all perfectly regular. There are only four inframarginal scuta, of which the second from front is the largest, forming, with the third, an angle projecting inwards.

The carapace and plastron are smooth, excepting in the lines of the sutures of the costal bones. In this position there is, in each case, a series of short pit-like grooves parallel to each other, and transverse to the axis of the bone, forming figures like some Hebrew letters, the Greek *//*, etc.

The borders of the carapace are obtuse, and the general form is almost round. The diameter is almost eighteen inches.

This species may only be compared with the *B. undata*, Leidy, with which it agrees in having the humeral scuta crowded to the front of the plastron, and having a common centre with the gulars, which they little exceed in size. It differs in having four instead of five inframarginals, a differently formed first costal, *wider lateral marginals*, and in the smooth carapace with the peculiar sculpture mentioned.

Testudo hadriana. Cope, spec. nov.

Indicated by two individuals, one nearly perfect, the other chiefly represented by a complete plastron.

This proves the existence of a very massive species of the terrestrial genus Testudo. The plastron presents a short wide lip in front, which is turned outwards, forming a strong angle with the plane of the upturned front of the lobe. This lobe is bordered by a thickening of the upper surface, which cuts off the basin from the lip, as a high ridge. The posterior lobe is deeply bifurcate, each post-abdominal projecting as a triangle. There is a notch at the outer angle of the femoral scute. The hyposternal bone is greatly thickened within the margin above, and an elevated ridge bounds the basin of the plastron behind, as before. The middle of the plastron is thin.

The carapace is without marked keel or serrations. It is remarkable for its expanded and truncate anterior outline, which is nearly straight between two lateral obtuse angles.

Length carapace, M. .750=29 inches; width, .630.

The marginal scuta are narrow, and there is a large nuchal plate.

Same locality as the last.

Palæotheca polycypha.

This genius and species of tortoises are indicated by vertebral, costal

and marginal bones of very small individuals. These bones are, however, not only thoroughly ossified, but are very stout, indicating the adult age of the animal. The deeply impressed scutal sutures and heavy proportions, as well as the elevated carnia of the carapace, indicate affinity with *Cistudo*, or perhaps, *Testudo*, as another generic character, it may be noted that the vertebral bones are subquadrate, and support the neural canal without intervening lamina.

The carina of the carapace is abruptly interrupted occasionally ; sometimes with, sometimes without, a pair of pits, one on each side. The marginal bones are well recurved, and the scutal sutures are deeply impressed on them.

	M.
Length of vertebral bone	.009
Width " "	.0085
Length marginal "	.01

This is least of the tortoises of the Bridger Formation.

PALÆOTHECA TERRESTRIS. Cope.

Represented by three individuals, one of which may be regarded as the type. They are all thinner than the *P. polycypha*, and larger, being about equal to the *Aromechelys odoratas* of our ponds.

In the type specimen the carina of the vertebral bones is interrupted by a deep sutural groove, which is less pit-like than in *P. polycypha.* The bone itself is broader than long, being, perhaps, from the hinder part of the carapace. The clavicular (episternal) bone is preserved. It is characterized by the considerable and abrupt projection of that part enclosed by the gular scutum, which resembles what is sometimes seen in *Testudo.* The edge of this part is entire and acute. The posterior part of the projection forms a step-like prominence behind, on the superior or inner face. The bone is almost as wide as long, and the mesosternal causes a very slight median truncation, but overlapped much on the inner side. The gular dermal suture does not reach it.

	M.
Length vertebral bone	.009
Width " "	.018
Length episternal	.02
Width " (transverse to axis of body)	.017
Width of the costal	011
Thickness proximally	.003

In the second specimen, a strong groove is seen to bound the lip of the front lobe of the plastron as in the species of *Notomorpha.* In it the marginal is seen to be stout, a little recurved, and sharp-edged. A vertebral differs from those described in being longer than wide.

In the third individual the gular lip is not so prominent as in the type, and the mesosternal bone truncates the clavicular extensively, giving it thus a more elongate form. The gular scuta expands to its front margin. The marginal bone is stout and sharp edged, and is not so deeply impressed by the dermal suture, as in *P. polycypha.*

Length episternal	.016
Width "	.026

Length marginal	.011
Width "	.016

The three specimens are from the bluffs of Cottonwood Creek, Wyoming.

NAOCEPHALUS PORRECTUS. Cope.

Gen. et sp. nov. Lacertiliarum.

Established on an incomplete cranium, with vertebræ found associated. No teeth are preserved, nor any part of the mandible. The remaining portions of the cranium are, however, highly characteristic.

The occipital descends posteriorly and bears a pair of lateral ridges, which converge rapidly posteriorly. This bone is united with the parietal by suture, which is transverse; its outline is rectangular, so as almost to reach the frontals, which are prolonged backwards on each side the parietal, leaving but a narrow exposure of the posterior processes of the parietal. These extend backward, and are broken off in the specimen, but they probably formed parts of arches. The parietal is single, and there is no parietal fontanelle. The bone is triangular in outline with the apex anterior, dividing the frontals. These are contracted at the orbits, and have a projecting superciliary head; anteriorly they are thickened. The postfrontals are of remarkable form. They are massive, and compressed from before backward; they rise considerably above the level of the front, and bear on their summits a cotyloid cavity, which is transverse to the exis of the cranium; the use of this projection is obscure. There is an exoccipal foramen, and a large one in the posterior part of the frontal opposite the postfrontal elevation.

The sphenoid is a compressed keel-shaped bone, round below, and with broad alæ along much of its length. The occipital condyle is subcondate depressed in outline, with a vertical obtuse angle in the middle and the sides somewhat plane.

A dorsal vertebra preserved has a single vertical capitular process, and a short hypapophysis. The neural canal is large, and the neurapophyses are attached by sutures. The cup is nearly round, very slightly transverse, and vertical.

The cranium is smooth above, except the anterior part of the frontals, which are finely rugose.

This genius is more or less allied to the *Thecoplossa*, but better material will be requisite to decide the question of affinities fully.

Found with the preceding specimens.

	M.
Width cranium at postfrontals	.072
" parietal behind	.012
Depth postfrontal	.018
" pre-sphenoid anteriorly	.014
Diameter dorsal vertebra (cup)	.007

This genius differs from *Glyptosourus*, Marsh, in the total lack of cranial shields, and from *Sauiva*, Leidy, in the nearly round vertebral centra.

July 29, 1872.

NO. 2.

SECOND ACCOUNT OF THE NEW VERTEBRATA FROM THE BRIDGER EOCENE.

By Edward D. Cope.

Helotherium procyoninum. Cope.

Spec. nov.

This species is distinguished from those already known as pertaining to this genus, by its small size, as it does not much exceed the raccoon in dimensions. The size of a right superior molar is as follows :

	M.
Length	0.007
Width posterior	.0085
" anterior	.006

The crown presents four tubercles, of which the inner are flat on the posterior, the outer flat on the external side. The posterior external has a small posterior supplementary lobe, and a low tubercle intervenes between the two posterior. An anterior and a posterior cingulum. Enamel smooth.

Stypolophus pungens. Cope.

Gen. et spec. nov.

This genus is supposed to embrace a small species of carnivorous animal found by the writer in the Eocene formation of the Bridger Group, It is represented by the posterior portion of the left mandibular ramus, which contains the last two molars.

The generic characters are seen in the composition of these molars, which have but two roots, and a posterior table, as is seen in tubercular molars of some *mustelidæ*. The anterior, two-thirds of the crown is composed of conic cusps. On the last molars these are in two series, two lower of the inner, and one more elevated, of the outer, opposite the interval between the outer. Its outer face is regularly convex, but its posterior forms, with that of the outer series, a single flat vertical plane, which forms a sharp angle with the inner and outer faces of the cusps.

The structure is, in general, somewhat like that of *Mesonyx*, Cobe but the lack of cutting edge on the posterior lobe, and the two rows of tubercles separates it at once. Dr. Leidy describes *Sinopa*, as having a sectorial tooth as in ordinary *Carnivora*, with an interior cusp, hence it is not probably the present form, although this species was about the size of the *S. rapæx*.

The enamel is smooth. The measurements are :

	M.
Depth ramus at last molar	0.011
Length last molar	.0072
Width " posteriorly	.0040
Height inner tubercle	.0062
" external "	.0040

This species was about the size of the gray fox.

From the bluffs of Cottonwood Creek, Wyoming.

PANTOLESTES LONGIEUNDUS. Cope.

Gen. et sp. nov.

This form is one of those mixed types which are so abundant in the Bridger Group. Its dental formula is M. 3, P. M. 3; c. 1. incisors unknown. The molars in the only specimen known are worn as to preclude exact description. They evidently possessed anterior and posterior lobes, separated by a valley, which was most expanded on the inner side. The last molar exhibits a projecting keel posteriorly, which probably supported a small tubercle. The three premolars are all two-rooted and compressed in form. The last presents a crown composed of one large anterior compressed cusp, and a much lower posterior one. There is a slight cingulum in front. The canine is lost, but its alveolus indicates that it was a stout tooth.

So far as the known dental structure goes, this genus resembles nearly the *Notharctus* of Leidy (*Limnotherium* of Marsh), but possesses one premolar tooth less.

The mandibular ramus is quite slender, and there is a large foramen below the first true molar. The masseteric fossa is pronounced.

	M.
Length of dental series to canine	0.0280
" " three molars	.0140
" " second "	.0041
Width " " "	.0030

There were found associated with this jaw some caudal vertebræ of very attenuated form, which point to the possession of a long tail by this animal. One of these displays six short processes arranged round the articular extremity, the neural arch not being completed.

	M.
Length	0.016
Proximal diameter	.003
Median "	.0018

PSEUDOTOMUS HIANS. Cope.

Gen. et sp. nov.

This form is interesting as the only member of the Edentate order yet discovered in our early Tertiary formations. It is represented by a species of which a nearly perfect cranium is in my possession. This is about the size of an agonti and is of a depressed form. It has a thin molar and zygomatic arch, but no postorbital. There is a large suborbital foramen. The dentition consists of two pairs of long curved teeth, having much the form and position of the cutting teeth of *Rodentia.* These are placed widely apart in the upper jaw, allowing space for the greater portion of the premaxillary between them. The mandibular cutters are less widely separated by a narrow prolongation of the symphysis. The exposure of the tooth is lateral, its direction nearly anterior. It projects anteriorly very little beyond the symphysis, and has a horizontal triturating surface below the level of the latter. Neither pair of cutting teeth

are faced with enamel, but have only smooth cementum without sculpture. There are no molars, but the inferior face of the maxillary bone is rugose as though alveoli had been absorbed. There are traces of very shallow alveoli.

The cast of the brain indicates smooth oval hemispheres which leave the cerebellum and olfactory lobes entirely exposed. The latter are ovoid and expanded laterally.

The cranium is depressed, and has a trace of interparietal crest. The anterior margin of the temporal fossa is marked by a curved angle on each side of the frontal bone. The supra-orbital arch is very short.

This curious animal reminds me of a small *Megalonyx* with flattened cranium. The cutting teeth above are, however, more like those of rodents.

	M.
Length cranium (3.5 in.)	0.090
Width " (without zygomas)	.040
" " near end of nasals	.027
" upper cutting tooth	.007
Depth " " "	.0085
Length exposed part lower tooth	.009
Width " " " "	.006

HADRIANUS OCTONARIA. Cope.

Gen. et sp. nov.

This is genus of true *Testudinidæ*, designed to include those with double anal scuta, and posterior lobe of the plastron bifurcate. In addition to the species above named, the *H. quadratus* (*Testudo hadriana*, Cope), and probably the species to which belong a small piece named by Leidy, T. *corsoni*, pertain to the genus.

The *H. octonarius* is distinguished from its congener in many ways. It is of elongate form, strongly contracted at the bridges, but expanded and arched above the limbs. The carapace in quite convex. The plastron has the posterior lobe emarginate rather than bifurcate, as seen in *H. quadratus*. Each projection represents a right-angled triangle rather than a wedge. The anterior lobe presents an elongate lip, which is expanded, and slightly emarginate at the end. The mesosternal bone is heart-shaped, the posterior emargination being wide and deep.

The anterior margin of the carapace is somewhat flared above the limbs. The muchal scutum is very narrow transversely, but elongate. The carapace descends and is incurved in the middle of the posterior margin.

	M.
Length (below)	.730
Width at middle	.437
" at hind limbs	.525

This species differs from the *H. quadratus* in many important points. It is perhaps the largest of our extinct land tortoises, and is founded on a beautifully perfect specimen from the bluffs of Cottonwood Creek.

August 3*d*, 1872.

NO. 3.

THIRD ACCOUNT OF NEW VERTEBRATA FROM THE BRIDGER EOCENE OF WYOMING VALLEY.

By Edward D. Cope.

Stypolopus insectivorus. Cope. Sp. nov.

Represented by a posterior molar and a premolar of the right side of an animal less than half the size of the *S. pungeus*, Cope. The molar presents three anterior trihedral acute tubercles, of which one is exterior and more elevated than the others. Its posterior plane forms one transverse face with that of the inner posterior. The posterior tubercular heel is low, and supports an oblique ridge which bounds a deep groove behind the outer cusp, no doubt to receive that of the upper jaw. This arrangement is not seen in *S. pungeus.* The premolar is a flat cone with faint traces of a tubercle behind and cingulum on inner side.

	M
Length crown molar	0.0050
Height inner cusp	.0040
Length heel	.0025
Width crown	.0030
Height crown premolar	.0040
Length " "	·0040

Found in the Eocene Bad Lands of Black's Fork, by the writer.

Stypolophus brevicolcarabus. Cope. Sp. nov.

Established on a portion of the left mandibular ramus, containing the penultimate and ante-penultimate molars, of an animal of a larger size than the type of the genus *S. pungeus.* The molars have the general characters of the corresponding ones of that species, but differ in their greater elevation in comparison with their length, and the greater convexity of the outer side. The shortness is occasioned by the abbreviation of the heel, which in the last molar present, is very small and flat, without keel or tubercle on its surface. That of the molar preceding it is larger, and presents in its elevated outer margin, a trace of the keel seen in the smallest species. Enamel smooth.

	M.
Length of two molars	0.016
" " penultimate crown	.008
Width " " "	.0047
Length " " "	.002

There is some relation between *Stypolophus* and *Triacodon*, Marsh. If the heel of the molars of the former were wanting, they would be those of the latter. The premolars might be supposed to have this structure, but the form seen in *S. insectivorus* disproves this view. In fact, I have seen both molars and premolars of *Triacodon aculeatus*, Cope, and the former lack the heel of the *Stypolophi* entirely.

Miacis parvivorus. Cope. Gen. et sp. nov.

Established on a portion of the right ramus mandibuli, containing portions of three molars, the penultimate being perfect. As in *Canidæ*, the molars diminish in size posteriorly, the last being single-rooted, the penultimate being two-rooted. The structure of that tooth is approximately that of *Stypolophus*, *i. e.*, with three trihedral cusps in front and a heel behind, but the cusps are of equal height, and their point of union not raised above the surface of the heel. This is a valley bounded by a sharp margin which is incurved to the outer cusp, leaving a vertical groove on the outer side, as in *Stypolophus* sp. This genus further differs from that one in the single-rooted small tubercular posterior molar, which is wanting in that one. The ante-penultimate molar is much larger than the penultimate. The crown of the latter is laterally expanded, and bears a cingulum at the base antero-externally. Enamel smooth.

	M.
Depth ramus st penultimate molar	0.0080
Length crown of " "	.0040
Elevation " " "	.0025
Width " " "	.0033

Found on Black's Fork of Green River. An ally of *Stypolophus* and *Triacodon.*

Tomitherium rostratum. Cope. Gen. et sp. nov.

Allied to *Notharctus*, Leidy. Dental formula $\frac{?}{2}\frac{?}{1}\frac{?}{4}\frac{?}{3}$, in an uninterrupted series. Last molars with five tubercles, others with four; all low and slightly alternating, the outer wearing into crescents. Canines quite small. Incisors very prominent, the median pair with transverse cutting edges. Symphysis coössified, projecting in front.

I base the distinction between this genus and *Notharctus* on the small canine, and the sub-horizontal position of the incisors; believing that when other portions of the skeleton are studied, other differences will appear. This, I have the opportunity of doing with material now in my hands.

The adjacent horns of the two outer crescents unite with the anterior outer tubercle; the posterior outer is insignificant. There is a projection but no tubercle in front of the outer anterior tubercle. The first and second premolars have but one root, the base of the second being about the size of the base of the canine. The latter are cylindric at base. The inscisors form a parabolic outline, and have entire edges, the middle pair transverse ones. Enamel generally smooth, premolars somewhat striate; an indistinct inner cingulum.

	M.
Length of entire dental series (straight)	0.044
" symphysis mandibuli	.020
Depth ramus at second molar	.010
Length crown of " "	.006

	M
Width crown of second molar	.0045
" between two " "	.014
" " " canines	.005

From near Black's Fork of Green River.

I would refer to *Notharctus*, my *Lophiotherium vasachiense*, adding the fifth species to the genus. These are *N. gracilis*, Marsh. *N. tyrannus*, Marsh, *N. tenebrosus*, Leidy, *N. robustior*, Leidy, and *N. vasachiensis*, Cope.

HADRIANUS ALLABIATUS. Cope.

This large land tortoise is nearer in general form to the *H. quadratus* than to the *H octonarius*, but differs from both in the absence of the projecting lip of the anterior lobe of the plastron, which is thus simply truncate. The mesosternum is not cordate, but has much the shape of that of *H. quadratus*, that is, rhombic. The scutal sutures are deeply impressed. The plastron is strongly concave. Carapace without irregularities of the surface. Length eighteen inches.

From the Bad Lands of Cottonwood Creek, Wyoming.

EMYS LATILABIATUS. Cope.

Represented by a perfect specimen of a tortoise of a broadly oval form, and somewhat terrestrial habit. Its prominent characters are to be seen in the plastron, of which the posterior lobe is deeply bifurcate. The anterior lobe is peculiar in the unusual width of the lip-like projection of the clavicular ("episternal") bone, which is twice as wide as in *E. cyomingensis*, and not prominent. Bones all smooth; margins of lobes of plastron thickened. Length of shell, one foot.

	M.
Width of lip of plastron	.06
Depth of posterior notch	.02

From near Black's Fork of Green River.

PROTAGRAS LACUSTRIS. Cope.

Gen. et sp. nov.

A serpent of about the size of the existing "Pine Snake" (*Pityophis melanolencus*), and allied to the water snakes of *Tropidonotus* and allied genera.

A vertebra before me has the longitudinal hypapophysial groove of that group, which terminates in a very obtuse point. The ball looks extensively upwards. The upper articular extremity of the parapophysis is short and obtuse, and the inferior equally so, and directed shortly downwards. The articular face being continuous with each other. It sends an obtuse keel backwards, which terminates in front of the ball. The angle connecting the diapophysis and zygapophysis is strong, while the former was narrow; in the specimens it is broken.

	M.
Length of centrum below	0.009
Depth to base neural spine, in front	.011
Width cup	.0054
Depth "	.0045
Expanse parapophyses above	.012
" " below	.008

From the Bad Lands of Cottonwood Creek, Wyoming.

August 7, 1872.

NO. 4.

ON THE EXISTENCE OF DINOSAURIA IN THE TRANSITION BEDS OF WYOMING.

By Edward D. Cope.

During the present season, F. B. Meek, of Dr. F. V. Hayden's Geological Survey of the Territories, discovered some large bones near Black Buttes Station, on the Union Pacific Railroad, fifty-two miles east of Green River, and near the Hallville Coal Mines. Shortly afterwards I visited the spot with a branch expedition, and commenced excavations with a view to the recovery of the remainder of the animal. The position was discovered to be between the thinner or lower strata of the Bitter Creek series of coal, which at this point occupy a position of elevation and crop out high on the bluffs. Two strata appear above the sandstone in which the bones occur, and one below it. The portions of the skeleton found, rested in the midst of vegetable debris, as sticks and stems, and was covered with many beautiful dicotyledonous leaves, which filled the interstices between the bones. The plant-bed gradually passed into a shell-bed, containing numerous thin dimyaria, and close by, some oysters were found. The whole question as to geologic age and aqueous conditions during which these beds were deposited, being unsettled, I gave especial attention to the recovery of the bones, with the view of reaching a definite conclusion on these points.

We succeeded in recovering sixteen vertebræ, including a perfect sacrum, with dorsals and caudals; both iliac and other pelvic bones, those of one side nearly perfect; some bones of the limbs, ribs and other parts not determined.

The vertebræ are large. The dorsals are short, with vertically oval centra, and small neural canal. The diapophyses originate well above the neural canal, diverge upwards, and are triangular in section. The neural spine is very much elevated, and the arch short antero-posteriorly. The zygapophyses are close together in both directions, those of the same aspect being separated by a narrow keel only. They do not project, but consist of articular surfaces cut into the solid spine. The latter is flat and dilated distally. The articular faces are nearly plane with a slight median prominence.

The ribs have two articular surfaces, but I found no capitular pit on the dorsal centra.

Elevation of centrum, 7.5 in.; width of the same, 5 in. 7.5 lines; length of do., 3 in. 8.5 lines. Total elevation of a dorsal vertebra, twenty-eight inches three lines. The sacrum consists of five vertebræ, the anterior centrum not depressed. They give out huge diapophyses which are united by suture. They are themselves united distally in pairs, each pair supporting a longitudinal convex articular face for the ilium. Each pair encloses a perforation with the centra. The first diapophysis goes off from the point of junction of the first and second vertebræ, the second from the third only, and is more slender. The total length is 25 in.;

and the width 30 in. Its vertebræ are flat below, with latero-inferior angles. The last centrum gives off a simple diapophysis.

Another vertebra exhibits a diapophysis as low as the floor of the neural canal and united by coarse suture. Others posterior to the sacrum are more elongate with slightly compressed centrum, and with diapophysis opposite floor of canal and not united by suture. Centra flat below; no chevron bones discoverable. Length centrum, 4 in. 4 lines; depth of articular face, 4 in.; width of do. 4 in. 3 lines.

The iliac bone is extended antero-posteriorly. One extremity is thick and rather obtuse, but of little depth. There is a large protuberance above the acetabular sinus. The other extremity is dilated into a flat thin plate of rather greater length than the stouter extremity. From one of its margins, a rod-like element projects. Its total length is about four feet, of which the acetabular sinus measures about 8.10 inches.

A short bone pertaining to the limbs has the articular surfaces at a strong angle to each other, hence the shaft is twisted. It is deeply grooved on one side near the extremity. The other extremity bears a rather flattened hour-glass shaped articular face, and below it on one angle is a crest. The convexity of the surface is not great, and this extremity resembles that of a Dinosaurian or Crocodilian reptile. Its length is, however, only eight and a quarter inches; apparently too small for a humerus, though this is not certain, while it is decidedly too small for a metatarsal of such an animal.

From the above description, it is evident that the animal of Black Buttes is a Dinosauran reptile, the characters of the sacral and iliac bones alone sufficing to demonstrate this point. If the reader will compare the measurements given for species of this group already known, he will observe that those of the present animal exceed those yet described from North America. It is possible that if the corresponding parts of *Hadrosaurus tripos*, Cope, or *Thespesius occidentalis*, Leidy, are discovered, they may approach it.

It is thus conclusively proven that the coal strata of the Bitter Creek Basin of Wyoming Territory, which embraces the greater area yet discovered, were deposited during the Cretaceous period, and not during the Tertiary, though not long preceding the latter. It appears that the forests that intervened between the swamps of epochs, during which the coal was formed, were inhabited by these huge monsters. That one of them laid down to die near the shores of probably a brackish-water inlet, and was soon covered by the thickly fallen leaves of the wood. That continued subsidence of the level submerged the bones, which were then covered by sand.

The form of the ilium differs very materially from that of *Hadrosaurus*, and the vertebræ are plane, thus differing from *Thespesias*. The limb bone is distinct from anything in *Lælaps*, which, moreover, probably resembles *Thegalosaurus* in its ilium. The present form recalls rather *Cetiosaurus*. As it is evidently new to our system, it may be called AGATHAUMAS SYLVESTRIS.

NO. 5.

The Secretary announced that he had received, August 17th, 1872, a telegram from Professor Cope, dated Black Buttes, Wyoming, Aug. 17, 1872, reading (with conjectural corrections of specific names) as follows:—

Black Buttes, Wyoming, *August*, 17, 1872.

I have discovered in Southern Wyoming, the following species: Lefalaphodon, Cope. Incisor one; tusk canine none; premolars four, with one crescent and inner tubercle; molars two; size gigantic.—*Discornatus;* horns tripedral, cylindric; nasals with short convex lobes.—*Bifurcatus,* nasals with long spatulate lobes.—*Excressicornis,* horns compressed sub-acuminate.

Edward D. Cope,
U. S. Geological Survey.

Published Aug. 19, 1872.

NO. 6.

NOTICES OF NEW VERTEBRATA FROM THE UPPER WATERS OF BITTER CREEK, WYOMING TERRITORY.

By Edward D. Cope.

Synoplotherium lanius. Cope. Gen. et sp. nov.

This genus possesses the dental formula so far as known, I. $\frac{3}{1}$c.$\frac{1}{0}$M$\frac{?}{6}$. In the only specimen with molars, the crowns are much worn, but in all the antero-posterior much exceeds the transverse diameter, and consisted of two lobes. The posterior molar had no more lobes, and is smaller than the penultimate. The first is two rooted, and is separated by a wide space from the inferior canine. The superior canine is of disproportionately large size, and issues a little behind the premaxillary suture. The incisions are crowded closely together, and are of conic form. The exterior is several times as large as the others. The inferior incisors are of huge size, project upwards after the manner of rodents, and are inserted by a short base into the solid symphysis. They are separated by a short interspace, which is without alveoli.

The fore foot possesses four digits, of which the inner is considerably the shorter. Phalanges not slender; ungueals flat, deeply fissured above. Caudal vertebræ slender.

This most remarkable genus is not at present referable to its proper order. The superior anterior teeth are of carniverous type; the opposing teeth look like those of rodents, while the molar teeth differ from both. It is allied to *Anchippodus*, Leidy, which is only known from mandibles. This form Dr. Leidy has called the "gnawing hog," but, as it probably exhibits a structure similar to that seen in the present genus, it is obvious that the huge symphyseal teeth were not designed for gnawing in the usual sense. I suspect these animals have lived largely on turtles,* and that the structure in question was adapted for crushing their shells. This is the more likely from the prodigious number of turtles which must have existed contemporaneously with them. There are twenty species described from the Bridger formation, and their numbers are legion, as already described by Professor Marsh. Their bones are always in sight, and six or eight are not unfrequently found lying together.

Char. specif. The mandibular rami, posterior to the symphysis, are not heavily constructed. The symphyseal teeth are very stout, and exhibit two longitudinal grooves on the outer and outer inferior face; the shaft is compressed, and the worn surface is on the outer side, as produced by the canines, and on the extremity, produced by the outer incisor. The superior canine is compressed, and as large as that of a grizzly bear. The outer incisor is nearly straight, and with conic crown. A large part of its shaft is exposed at the bottom of a wide vertical groove, which extends upwards between the canine tooth and a ridge descending from the edge of the nares. The external nareal opening is en-

*This view was already expressed in *The Friend*, Philada., 1872, Winter.

tirely anterior, and is narrowed below, in accordance with the narrowing of the premaxillaries.

	M.
Length of interior dental series to bases of symphyseal tooth	0.170
Depth ramus at last molar	.050
Length symphysis	.060
" muzzle from canine	.017
" symphyseal tooth projected	.010
Diameter " " "	.026
" canine " "	.023

If the body of this animal were of usual proportions as relates to the skull, it was about the size of the black bear (*Ursus americanus*). The worn condition of the teeth indicates an old animal, and one that had lived on hard food.

EOBASILEUS CORNUTUS. Cope.

Gen. et sp. nov.

Established on remains of five individuals of the average size of the *Mastodon ohioticus*. These indicate clearly a form of proboscidian not before recognized. The structure of the tibia and astragalus, clearly indicate that the species is not artiodactyle, while the perfectly simple femur is not perissodactyle. The posterior part of the cranium, and the short stout phalanges are proboscidian. The existence of horns on the frontal bones separates it at once from *Dinotherium*, *Mastodon*, *Stegodon*, or *Elephas*, and indicates a remarkable combination of structure not before known to naturalists. The gigantic size of the typical species adds to its interest, and shows it to have been the monarch of the remarkable fauna disclosed by recent researches in Wyoming.

The distal extremities of both humerus and femur are flat, the former with oblique trochlear face and shallow olecranar fossa. The great trochanter of the femur is flat and not recurved; little trochanter wanting. Spine of tibia very obtuse; distal extremity little excavated. Distal extremity of phalanges not divided by trochlear ridge.

Articular extremities of vertebræ plane; the cervicals very short.

Cranium with vertical occiput with broad convex superior outline. Temporal fossæ lateral, posteriorly small. Horn-cores obtuse, compressed, most at base; direction divergent.

NUMBER 1.	M.
Length of horn-cores (6 inches)	0.152
Elevation occiput from the foramen magnum	.180
Width across supra-occipital crest	.315
" of condyles with foramen	.206
" " paramastoid process	.087

NUMBER 2.	
Transverse diameter condyles humerus	.185

Number 3.

Diameter extremity	tibia	(transverse)	.126
" "	"	(antero-posterior)	.096
" head	"	(transverse)	.140
" glenoid cavity scapula			.150

Further details of the structure of this animal will be sought for with interest. From the manner of its occurence, it probably went in families or herds.

Crocodilus clavis. Cope.

This is a large species with a muzzle of narrowed proportions and sufficient depth to give it a broad oval section. The nasal bones appear to have reached the nareal orifice. The anterior superior teeth are very large, especially the canine. The inferior tooth corresponding is large, and occupies an emargination which approaches near to the nasal suture. The pitting of the muzzle is fine, and the swollen interspaces much the wider. The teeth have stout conic crowns, with well developed cutting edges and coarse striate sculpture. The mandible is acuminate to the narrow extremity, and has a long symphysis, which extends to opposite the third tooth behind the notch. The cervical vertebræ preserved, have round cups; they have a simple elongate hypapophysis with a pit behind it; shoulder very prominent.

	M.
Length of ramus with teeth	
" " symphysis	.135
Width do. at end of symphisis	.085
" do. " mandible	.020
" maxillary at third tooth above	.060
" " " notch above	.020

This species has a more slender muzzle than those described by Marsh and Leidy, and is of larger size.

Rhineostes peltatus. Cope.

Gen. et sp. nov. Nematognathorum.

Established on cranial and other bones, with spines of a siluriform fish of the size of the largest species of *Amiurus*. The form, in the excessive rugosity of the external long surfaces, reminds one of some of the Brazilian *Dorades*. The frontal fontanelle is closed, though very distinctly marked by a groove of the surface not rugose. The rugosity consists of innumerable, packed osseous popillæ. The cranial ossification is continued posterially as a shield, which is strongly convex from side to side. The spine is symmetrical, and probably dorsal. It is compressed and curved antero-posteriorly, and is deeply grooved behind. Laterally it is closely striate grooved; the anterior face is narrowed, obtuse, and minutely serrate with cross ridges; each side of it is rugose with several irregular series of pronounced tubercles, arranged transversely.

	M.
Width frontal bone near front of fontanelle	0.012
Thickness at do.	.004
" " casque	.005
Width spine	.005
Depth "	.009

RHINEOSTES SMITHII. Cope.

Indicated by a dorsal spine of an individual of smaller size than the type of the last named. It is less rugose, and more firmly striate, and possesses a row of short reverted spines in its posterior groove. The anterior edge is furnished with a finely serrate keel, which has a groove on each side at the base. The section is oval, the posterior face not being flattened as in the last species. Anterior-posterior diameter near middle M. .005 ; at base .006 ; width behind above base .006.

Named for my respected friend, Daniel B. Smith, of Germantown ; many years Principal of Haverford College, and a student and lover of the Natural Sciences.

August 20th, 1872

NO. 7.

SECOND NOTICE OF EXTINCT VERTEBRATES FROM BITTER CREEK, WYOMING.

By EDWARD D. COPE.

PALÆOSYOPS VALLIDENS. Cope, sp. nov.

Represented by the dentition of one maxillary bone with other bones of one individual; a portion of the same dentition of a second; with both rami of the mandible with complete dentition of a third. The species is distinguished by the details of the dental structure, and by the superior size. It exceeds, in this respect, the *Palæosyops major*, Leidy; while the three posterior lower molars measure 4.5 inches in length. the same teeth of the present animal measure 5.25 inches. The last superior molar of another specimen measures 2 inches in length; in the third the first true molar is 1.5 inch in length, while the last inferior molar is 2.25 inches long. The peculiarity in the structure of the superior molars consists in the existence of two strong transverse ridges, which connect the inner tubercle with the outer crescents, enclosing a pit between them. These are most marked on the premolers, where also is found the peculiarity of the almost entire fusion of the outer crescents into a single ridge. These united crescents are narrower than in *P. major*, and the summits of all the crescents are relatively more elevated. The number of inner tubercles is the same as in that species; all the teeth have very strong basal cingula, which rise up on the inner tubercle. The last inferior molar is relatively narrower than in *P. major*, and the posterior tubercle is larger and longer, and is an elevated cone.

This species is after those next described, the largest mammal of the Wyoming Eocene.

LOXOLOPHODON. Cope.

(Proceed. Amer. Philos. Soc. Feb. 16, 1872.)

The discovery of the remains of numerous animals of this genus confirm the propriety of its separation from *Bathmodon*. The characters are as follows:

Type of extremities Proboscidian. Femur without third trochanter, toes short, stout. Dentition: I. 1; C. 0: P. M. 4; M. 2. The premaxillary is at the posterior margin of that bone, and is a large recurved trenchant tusk. There is a long edentulous interval between it and the first premolar, which is smaller than the others. These support an outer crescent and a small inner tubercle. In the anterior premolars, the crescent is nearly straight, in the posterior more curved. With use, the crescent and tubercle wear together and form a short lance-head surface. The crescent is angular, and occupies the whole crown in the molars, and the tubercle is small and not symmetrically placed. The teeth on the maxillary bone are remarkably small for the size of the animal. Lower jaw not observed.

The cranium presents a remarkable appearance on account of the pro-

longation of the muzzle. In front of the zygomatic arches, the form is compressed and roof-like above. Above the tusks the nasals expand, and are produced to a great distance, terminating in osseous prominences. The premaxillaries are also much produced ; their anterior part is slender and toothless, and does not extend so far as the nasals.

The orbit is not enclosed behind, and has no marked superciliary or other margin. Above it, on each side, a horn-core is given off, the pair diverging from approximated bases. Occiput vertical.

The affinities of this genus are not close to any known, excepting *Bathmodon.* This has the six premaxillaries of usual proportions, at least three true molars, and the posterior premolars with three crescents. The general relationships are proboscidian, and associated in some measure with *Synoplotherium*, *Auchippodus* and *Pseudotomus.*

Besides the *L. semicinctus*, Cope, originally described, the researches under Prof. Hayden's Geological Survey, have determined the existence of two or three other species of much larger size.

LOXOLOPHODON CORNUTUS. Cope.

Eobasileus cornutus. Cope.

Established on portions of several skeletons, including one with femur, pelvis, scapula, vertebræ and cranium. The latter measures about thirty-four inches in length. The horn-cores are very stout and sub-triangular in section at base and with a rudimental knob on the inner side ; height seven inches about. A massive protuberance of a recurved lobate outline rises on the anterior margins of the nasal bones on each side. They meet, leaving an emargination in front, giving the nasal bones a bi-lobed outline. The iliac bones are very wide, the expanse of both together being fifty-four inches. The centrum of a sacral vertebra is four inches in diameter.

LOXOLOPHODON FURCATUS. Cope.

This species is indicated by portions of the nasal bones. These have differed in form materially from those of the *L. cornutus.* The convex protuberances seen in *L. cornutus* were here represented by processes of singular form. They were compressed, narrowed at the base, and expanded distally into a flat spatulate body. The whole process measures seven to eight inches in length, and three and a-half in width distally. The animal could not have been materially smaller than the *L. cornutus.*

LOXOLOPHODON PRESSICORNIS. Cope.

Established on numerous remains, including horn-cores of species similar in size to the last. Its marked peculiarity, as first noticed, consists in the compression of the horn-cores throughout the proximal half of their length, with their more acuminate form, than in *L. cornutus.* They measure also about seven inches in length.

The affinities of these remarkable animals will be shortly discussed. They were the gigantic mammals of our Eocene period, representing the Elephants and Mastodons of the Miocene, which they equalled in size. *Aug.* 22, 1872.

NO. 8.

ON A NEW VERTEBATE GENUS FROM THE NORTHERN PART OF THE TERTIARY BASIN OF GREEN RIVER.

BY EDWARD D. COPE, A.M.

ANAPTOMORPHUS ÆMULUS. Cope.

Dentition of the *ramus* mandibuli, In. 2, C. 1, P.M. 2, M. 3, total 16; identical in number to those of *Limia* and *Homo*. It differs in many respects from these; there is no interruption in the series near the canine, and the symphysis though massive, is not co-ossified. Further details are, the last molar is three-lobed and elongated behind. The composition of the crowns of the preceding molars consists of four opposite lobes, which are very stout, and connected transversely by a thin ridge behind, or in close contact in front. The premolar tooth which is best preserved, is a perfect second, which, while having two roots, possesses a crown which stands almost entirely on the anterior, presenting a curved sectorial crest forwards and upwards.

Measurements.	M.
Length dental line	0.0148
" of last molar	.0030
" " ante-penult	.0025
Width of "	.0020
Length of three molars preserved	.0070

October 12th, 1872.

NO. 9.

DESCRIPTIONS OF NEW EXTINCT REPTILES FROM THE UPPER GREEN RIVER EOCENE BASIN, WYOMING.

By E. D. Cope.

Crocodilus (Ichthyosuchus) sublatus. Cope, sp. nov.

Some of the cervical vertebræ without hypapophyses. Their cups round. Dentition peculiar. One or two very long smooth compressed straight teeth in the front of the ramus mandibuli. These are followed abruptly by a closely set series of sub-equal teeth of not one-fourth the size, varying little to the back of the jaw. The long teeth have sub-compressed crowns with opposed cutting edges, and are smooth except at their bases. These are distantly sulcate, the separating ridges being acute. The smaller teeth are perfect cones and resemble those of Gars without their sulci.

There are more long teeth in the premaxillary bone than below. Pitting of the cranium distinct, elegant. Length of skull about one foot. Length of long teeth 1.25 inches ; of small ones .5 inch.

Crocodilus sulciferus. Cope, sp. nov.

A medium sized species with cranium deeply and roughly pitted. The chief character is at present visible in the teeth. The larger of these are of sub-cylindric and short conic crown, which is superficially grooved from basis near apex ; sulci coarse, open.

Anostira radulina. Sp. nov.

Based on two marginal bones one from the front, the other from the rear, of the carapace of an animal of twice the bulk of the largest *Anostere* yet found. Apart from size, the sculpture is peculiar. It consists in the anterior of closely packed vermicular ridges which run out flat on the posterior and upper edge. In the posterior, it consists of only closely placed minute tubercles over the whole surface.

	M.
Length front one on free edge	0.025
Width " " "	.028
Length posterior on free edge	.025
Width " " "	.025

October 12th, 1872.

NO. 10.

Prof. Cope made some remarks on the Geology of Wyoming, especially with reference to the age of the coal series of Bitter Creek. He said that the discovery of the Dinosaur *Agathaumas sylvestris* had settled the question of age, concerning which there had been much difference of opinion, in favor of the view that they constitute an upper member of the Cretaceous series. In the sections made, he had succeeded in tracing the line of demarkation between these and the lower beds of the Green River epoch, and had found the leaf beds of the former to be immediately covered by deposits of mammalian remains, with an interval of a few feet only. In the same way, the close approximation of Evanston cretaceous coal to tertiary strata was determined by the finding of numerous mammalian and reptilian remains in the lower part of the Wahsatch beds of Hayden, or even in the sandstones overlying the coal. Here two species of *Bathmodon* were found, corresponding with the nearly allied genus *Metalophodon* from the Bitter Creek locality. So far as is yet known, the *Bathmodontidæ* are diagnostic of the Green River formation, and on this and other grounds, the Wahsatch beds of Evanston were regarded as belonging to it. A further extension of the Green River formation was found at a point 400 miles westward (*see* Proc. Am. Philos. Soc., July, 1872), near Elko, Nevada, where fishes and insects occur in thin shales. Some of the former are nearly allied to species from the fish-beds of Green River.

He added that exception had been taken to his claiming the final determination of the cretaceous age of the Bitter Creek coal strata (*see* Silliman's Journal, 1872, Dec., p. 489); his critics presuming that he was unacquainted with previous publications on the subject. It was, however, his knowledge that previous authors had expressed either adverse or doubtful opinions respecting it, that induced him to print the short preliminary notes that had appeared. He was well aware that Messrs. King and Emmons had considered the lower part of these beds as cretaceous, and the *upper as tertiary* (*see* Exploration 40th Parallel, III. p. 458), on stratigraphic grounds. Since the cretaceous was represented in different parts of the country by clays, sands, glauconite, chalk, limestone, and sandstone, he thought that palænotological evidence was needed to complete the demonstration. This had not been produced for the locality in question, but the nearest point (Hallville) had been called Tertiary by Mr. Meek, and Prof. Lesquereaux (Hayden's Survey of Terrs., 1870, p. 306) had considered the fossil flora of Point of Rocks, forty miles westward, as of "unknown age," and those of Evanston as *miocene*. Hayden himself is well known to regard the strata as of uncertain or transitional age. Palænotological determinations of cretaceous age of the Bitter Creek series were very indefinite up to the publication in question. But, first he would remark, that his critic was doubtless uninformed as to the geography of Wyoming, when he cited Prof. Marsh's determination of the

cretaceous age of the coal of Brush Creek, a locality from 150 to 200 miles distant. So with the determination from Weber River (Coalville) 200 miles, and Evanston and Sulphur Creek 150 miles distant, on the opposite side of the Bridger Basin. He did not regard these as determinations affecting the age of the Bitter Creek Beds any more than they did of the Eocene coal of Osino, 200 miles west of them.

The only approximations to the point were made by Mr. Meek. In King's Survey of the 40th Parallel (l. c. 462), Mr. Meek's nearest points of investigation were the shell beds of Sulphur Creek (Bear River); of these he says, "While I am, therefore, willing to admit that facts may yet be discovered that will warrant the conclusion that some of these estuary beds should be included rather in the Cretaceous than in the Tertiary, it seems to me that such evidence must either come from included *vertebrate* remains, etc." This is not very conclusive, and acknowledges in advance the importance of the determination of vertebrates from the same neighborhood (Evanston), and from Bitter Creek, above described. Secondly, in Hayden's Survey, 1870, p. 298, the only determination of the age of coal of the Bitter Creek area is *tertiary* (Hallville). Thirdly, in Hayden's Survey Montana, etc. (1871, p. 375), Mr. Meek enumerates *three species* from this region (Point of Rocks) as cretaceous, *every one with question* as to determination, which, therefore, decides little as to the age of the beds. In the same way all his Coalville species are marked with question. In his earliest investigation in connection with Mr. Engleman, in Capt. Simpson's Report (1860), he expressly states that the age of the Bitter Creek coal series is *unknown.*

Thus it seems that a knowledge of the literature of the geology of the Bitter Creek coal, shows : I. The Messrs. King and Emmons on stratigraphic evidence referred the lower part to the cretaceous and the upper to the tertiary. That on Palæontological grounds, II. Mr. Lesquereaux regards them as tertiary; III. Mr. Meek's evidence is doubtful; * and, IV. Dr. Hayden has believed in a transition series.

Hence it appeared to the speaker, that the explorations directed by Dr. Hayden during the past season had contributed largely to our knowledge, proving the existence of an interruption between the cretaceous and tertiary formations; less it is true than that which exists elsewhere, and similar to that insisted on by Clarence King's survey in the region of Bear River and the Wahsatch country.

* This gentleman has stated in a letter to the writer that Bitter Creek Beds constitute a "new zone."

NO. 11.

ON TWO NEW PERISSODACTYLES FROM THE BRIDGER EOCENE.

BY EDWARD D. COPE.

LIMNOHYUS LÆVIDENS. Cope.

This species is one of the larger forms of the group originally represented by *Palæosyops*, and which has turned out to be so numerous in species. Thanks to the labors of Prof. Marsh, these have been placed on a recognizable footing, and I have been enabled to distinguish not only the species he has described but a few others in the collections obtained by Dr. Hayden's expedition of 1872.

The present species is chiefly represented by a nearly complete cranium with dentition, from Bitter Creek, and a cranium lacking the posterior part of one side and the lower jaw, from Cottonwood Creek. The molars have the general form of those of *L. robustus*, but the second superior premolar has but one outer tubercle. The cingula are much less developed than in that species; those between the inner cones of the molars being entirely absent. These cones are low, and with the rest of the crowns of all the teeth, covered with smooth and shining enamel. The anterior median small tubercle of the first true molar is wanting. The last true molar has but one interior cone.

The canine tooth is powerful and bear-like; the outer incisor is the largest. The premaxillary bones are short, and the side of the face elevated and plane to the convex nasal bones. Zygomatic arch massive.

	M.
Length molar series (No. 1)	0.140
" true molars	.085
" three incisors	.034
" crown canine	.030
" " last molar	.039
Width " " "	.036
Length cranium to occipital crest	.345
" true molars (No. 2)	.101
" last " " (oblique)	.030
Width " " " (transverse)	.038

The measurements of this species are intermediate between those of *Palæosyops paludosus* and *P. major*, of Leidy; those of the latter agreeing with the *Limnohyus robustus*, Marsh, and perhaps other species.

PALÆOSYOPS FONTINALIS. Cope.

A small species agreeing with the *P. paludosus* in the two interior cones of the last superior molar. It is represented especially by a considerable part of the cranium of an individual in which the last superior molar is not quite protruded, but with the other molars and last premolar of the permanent dentition in place. The enamel of these teeth is in accordance with the age, delicately rugose, and while the cingulum

is present fore and aft, it is wanting internally and externally. The anterior median tubercle is present on all the true molars, and the bases of the acute inner cones are in contact. The sagittal crest is truncate, and the squamosal portion of the zygoma very stout. The nasal bones are together very convex in transverse section.

	M.
Length of true molar series (2.75 in.)	0.067
" last "	.025
Width " "	.026
Length of penultimate molar	.026
" " "	.026
Depth of squamosal process	.025

Found by the writer on a bluff on Green River, near the mouth of the Big Sandy, Wyoming.

The papers descriptive of fossils from the Wyoming basin published by the writer during the year 1872, were issued at the following dates:

On *Bathmodon*, an extinct genus of Ungulates, February 16th.

On a new genus of *Pleurodira* from the Eocene of Wyoming, July 11th.

On the Tertiary coals and fossils of Osino, Nevada, July 29th.

Descriptions of some new *Vertebrata* from the Bridger Group of the Eocene, July 29th.

Second account of new *Vertebrata* from the Bridger Eocene, August 3d.

Third account of new *Vertebrata* from the Eocene of Wyoming Territory, August 7th.

On the existence of *Dinosauria* in the Transition beds of Wyoming, near August 12th.

Notice of *Proboscidians* from the Eocene of Southern Wyoming, August 19th.

Notices of new *Vertebrata* from the upper waters of Bitter Creek, Wyoming Territory, August 20th.

Second notice of Extinct *Vertebrates* from Bitter Creek, Wyoming, August 22d.

On the Dentition of *Metalophodon*, September 20th.

On a new Vertebrate genus from the northern part of the Tertiary Basin of Green River, October 12th.

Descriptions of new Extinct Reptiles from the Upper Green River Eocene Basin, Wyoming, October 12th.

I have just received a paper "On the Gigantic Fossil Mammals of the Order Dinocerata, by Prof. O. C. Marsh," which contains a formidable catalogue of errors which the author appears to suppose I have committed in describing animals of this type. All this is explained by the fact that Prof. Marsh has never seen the genus *Eobasileus*, Cope, and erroneously supposes it to resemble *Uintatherium*, Leidy (*Dinoceras*, Marsh). The descriptions which I have given are correct, as will presently appear, as well as the fact that I have anticipated the Professor in the descriptions of some of the allied species.

Issued January 31st, 1873.

NO. 12.

ON SOME EOCENE MAMMALS, OBTAINED BY HAYDEN'S GEOLOGICAL SURVEY OF 1872.

By Edward D. Cope, A. M.

(*Read before the American Philosophical Society,* ———, 1873.)

Hyopsodus paulus. Leidy.

Hayden's Survey, Montana, etc., 1871, p. 363.
From Cottonwood and South Bitter Creeks.

Microsyops vicarius. Cope, sp. nov.

Founded on portions of the mandibular rami of two individuals from the Bad Lands of Cottonwood Creek, Wyoming. These represent an animal considerably smaller than the *Hyopsodus paulus*, and with probably only three premolars. This is believed to be the fact from the small size of the last premolar, and the anterior contraction of the first molar. The molars have no external cingulum nor antero-external tuberosity described to exist in the *M. gracilis*, by Marsh. The cones have simple apices, and the oblique connecting ridges of both genera.

	H. paulus.	*M. vicarius.*
	M.	M.
Length of three molars	0.0136	0.0115
" last molar	.052	.0045
" first molar	.040	.0038
Width " anteriorly	.041	.0026
" " posteriorly	.043	.0029

Antiacodon pygmæus, Cope.

Lophiotherium pygmæum, Cope. Proceed. Amer. Philos. Soc., 1872, Extras July 29th. *Antiacodon venustus*, Marsh, Amer. Journ. Sci. Arts, 1872 (published, August 13th). *Hyopsodus pygmæus*, Cope, loc. cit., p. 461. From Cottonwood Creek, Wyoming.

Antiacodon furcatus. Cope, sp. nov.

Established on a part of the right ramus mandibuli with the three molars and last premolar in perfect preservation. The crowns of the molars are composed of two external chevron-shaped tubercles, the apices rising as acute cusps, and two internal cones, the interior of which is flattened and strongly bifid, both points being more elevated than any of the others. The cusps are nearly opposite to each other, and behind the interval between the two posterior rises another, not so elevated as the others, except on the posterior molar. Here it is elevated, and nearly equidistant from the two in front of it. The enamel is smooth, and there is no cingulum on either side. The premolar consists of a principal sectorial cusp, and has a smaller but stout acute anterior cusp, with a small rudiment of another behind; a stout cusp rises from the inner posterior margin of the principal one, giving it a subbifid appearance.

Measurements.	M.
Length of four molars	0.0195
" three true molars	.0149
" last " molar	.0055
" first " "	.0043
Width " " " in front	.0025
" " " " posteriorly	.0031
Depth ramus at front of M. 3	.0075
" " " P. M. last	.0055

This species differs from the last in the presence of the posterior tubercles on the M. 2–3, and the absence of external cingulum. The sizes are not very different.

From the Bluffs of the Upper Green River.

The genus to which this species belongs differs from *Hyopsodus* in the carnivorous form of the last premolar, which has a well-developed anterior cusp. I refer it to the same genus as the last species, though its characters have never been pointed out by the author of the name (Prof. Marsh), nor are the characters which distinguish it from *Homacodon* of the same author discoverable. He states that the cusps in *H. vagans* are "isolated," a character which does not apply to *A. furcatus*, in which they are related much as in *Hyopsodus*.

OLIGOTOMUS CINCTUS. Cope, gen. et sp. nov.

Char. Gen. Molars constructed much as in *Hyopsodus* and *Lophiotherium*, viz.: with two external subtrihedral cusps which wear into crescents, the posterior connected by a low oblique ridge with the basis of the anterior cone of the inner side ; the latter with two conic cusps. It differs from these genera and *Orotherium* in the possession of but two premolars; the inferior molars are probably six, leaving four true molars.

Char. specif. In this animal the cusps of the molars are elevated, the external most so, the anterior being somewhat bilobate. Premolars with two fangs. There is a rudimental posterior tubercle in M. 1 and 2, and a strong cingulum round the outer side of the crown. In an adult with worn teeth the enamel is obscurely rugose.

Measurements.	M.
Length of five molars	0.0326
" two premolars	.0120
" M. 2	.0067
Width " anteriorly	.0050
" " posteriorly	.0050
Depth ramus at front of P. M. 1	.0126

From Cottonwood Creek, Wyoming.

OROTHERIUM SYLVATICUM. Leidy.

Lophiotherium sylvaticum, Leidy. Proceed. Acad. Nat. Sciences, Philadelphia, 1870, 126. *Orotherium*, Marsh, Am. Journ. Sci. Arts, 1872, August 13. From Black's Fork, Wyoming.

OROTHERIUM VASACCIENSE. Cope.

Lophiotherium vasacciense, Cope. Proceed. Am. Philos. Soc., 1872, July 11th (extras). *Notharctus vasacciensis*, Cope, l. c., 1872, 474.

This species is similar to the last in most respects, the corresponding molars differing in the more elevated yoke between the tubercles of opposite sides, and the presence of a posterior median tubercle.

From Green River beds near Evanston, and the same near Black Buttes, Wyoming, on opposite sides of the Bridger Basin.

TOMITHERIUM ROSTRATUS. Cope.

Proceed Amer. Philos. Soc., 1872, August 11th, p. 470.

This genus differs from *Orotherium*, among other points, in the simple second premolar, which is without posterior cusp. It appears to be nearly allied to the *Thinolestes* of Marsh, and was published on the same day. That genus was, however, not distinguished by Marsh from *Notharctus* and *Limnotherium*, so as to be recognizable. The species differs from all those described by the same author, so far as I can discover.

NOTHARCTUS LONGICAUDUS. Cope.

Pantolestes longicaudus, Cope. Proceed. Amer. Philos. Soc., 1872, p. 467 (August 3d).

I originally assigned but 3 P. M., to this species, but now find that it possesses four, and must be referred to *Notharctus*. It differs from all the species described by Marsh, in having the second premolar two-rooted, and from Leidy's two species in its slender proportions.

TRIACODON ACULEATUS. Cope.

Proceed. Amer. Philos. Soc., 1872, p. 460, July 29th.

The measurements of this species are somewhat larger than those given by Marsh, for his *T. grandis* (Amer. Journ. Sci. Arts, August 13, 1872) ; but the species may prove to be the same. The allied genus *Stypolophus*, Cope, is no doubt marsupial.

VIVERRAVUS PARVIVORUS. Cope.

Miacis parvivorus, Cope. Proceed. Amer. Philos. Soc., 1872, 470, (August 7th).

This species appears to belong to the genus *Viverravus* of Marsh, which bears date July 22, 1872, consequently sixteen days earlier than *Miacis*, which thus becomes a synonym. The species is different from those described by that author.

PARAMYS LEPTODUS. Cope, sp. nov.

Established on a right mandibular ramus with all the teeth preserved. It indicates an animal of about the size of the *P. delicatus*, Leidy, and *P. robustus*, Marsh, but with smaller incisors, which have little more than half the diameter of the same tooth in those species. The molars have two anterior separate, and three posterior contiguous

cones, the median smallest. The anterior and posterior of both sides separated by a deep excavation. The anterior tooth is peculiar in its greater compression. The posterior tubercles are not separated, and the anterior inner situate behind the outer, and connected with the posterior inner by a concave ridge.

Measurements.

	M.
Length molar series	0.0221
" M. 4	.0060
Width "	.0055
Length M. 1	.0060
Width "	.0048
Diameter lower incisor, transverse	.0024
" " " anterior posterior	.0038

From the South Bitter Creek, Wyoming.

PARAMYS UNDANS. Marsh.

Sciuravus undans, Marsh. Amer. Journ. Sci. Arts, 1871 (June 21st).
A smaller species than the *P. delicatissimus*, Leidy. The dental characters of the mandibular series are generically indentical with those of the species of *Paramys*.

From Upper Green River.

PARAMYS DELICATISSIMUS. Leidy.

Black's Fork.

PARAMYS DELICATIOR. Leidy.

Cottonwood Creek and Black's Fork.

PARAMYS DELICATUS. Leidy.

Black's Fork.

PALÆOSYOPS DIACONUS. Cope, sp. nov.

Belonging to the genus *Palæosyops* as understood by Marsh, that is, with two cones on the inner side of the last superior molar. The species is as large as the *Limnohyus major* of Leidy, but differs in the relative proportions of the teeth. Thus the last three molars have the same antero-posterior length, while the space occupied by four premolars is shorter. The anterior and posterior cingula of the true molars are very strong, but it is not well marked on the inner side between the cones. The latter are acutely conic, and the median anterior tubercle is strongly developed. Although the wearing of the teeth indicates maturity, the enamel is coarsely and obtusely rugose. The fourth premolar differs from that of *L. major* in its smaller size relatively and absolutely, and in the presence of a prominent vertical tubercle on the outer face, rising to the angle of the deep notch between the lobes. The third premolar is as wide as the fourth and about as large as the corresponding tooth in *L. major*, but different from it in the absence of tubercle and ridge that mark its external face. The first premolar has two roots, and the canine is large and short.

This large Palæotheroid is represented by parts of the two maxillary bones, which present the crowns of the third and fourth premolars, and of the second and third true molars with the bases of the other molars and premolars.

Measurements.

	M.
Length of entire molar series	0.1710
" " true molars	.1060
" " last molar (crown)	.0420
Width " " " "	.0437
Length second molar	.0350
" fourth premolar	.0260
Width " "	.0260
" third "	.0200
Length " "	.0200
Diameter of basis of canine	.0263

In comparing this species with *P. paludosus*, which also has the dental crowns rugose, I have Dr. Leidy's descriptions of 1870* and '71. In the first he describes a superior molar as "22 lines fore and aft, and 18 lines transversely," which measurement would nearly apply to the penultimate of this species were the directions of the lengths exchanged. But in the second description,† the true molars are said to measure "3⅓ inches" in length, which is nearly an inch less than in *P. diaconus*. The species must therefore be different. In comparison with Marsh's description of his *P. laticeps*, the measurements are all larger, and the enamel is as rugose as in *L. major*, instead of smooth. The shortening of the premolar series is greater in *P. diaconus;* thus in *P. laticeps* the two sets of molars are related as 94 mm. to 61; in the present one, as 106 : 65; were the proportions similar, the length of the premolar series should be 69 mm.

From Henry's Fork of Green River.

The species of this genus then are, in the order of size: *P. diaconus*, Cope; *P. laticeps*, Marsh; *P. paludosus*, Leidy; *P. fontinalis*, Cope. There is however still some question as to the true position of *P. paludosus.*

HYRACHYUS IMPLICATUS. Cope, sp. nov.

This tapir is smaller and more slender than the *H. agrestis*, Leidy, but exhibits an equal size of posterior molar teeth, which are thus relatively larger than in that species. It is represented first, by both maxillary bones with most of the molars complete, from Cottonwood Creek, Wyoming; then by the side of the face with molars of both jaws complete, with symphysis and portions of all the incisors, from South Bitter Creek; and by part of mandibular ramus with teeth, from Green River, with probably other specimens.

* Proceedings Academy, Philadelphia, 1870, 113.

† Hayden's Geological Survey of Wyoming. 1871, p. 359.

The molars differ from those of the larger *Hyrachyi*, and resemble those of the smaller, in the presence of a prominent ridge which descends on the inner side of the principal (median) outer cusp, not quite reaching the valley below. It wears into a prominent loop. The anterior cusp is much less elevated than the median, and is separated from the latter by a considerable ridge. The only cingulum on the molars is on the outer side of the first; enamel smooth.

Measurements, No. 1.	M.
Length of five molars	.0710
" three posterior molars	.0470
" last molar	.0159
Width "	.0200
" penultimate molar	.0210
Length "	.0168

In the more perfect specimen, all of the molars have two transverse crests except the P. M. 1. The lower molars possess strong anterior prolongations of their posterior crests; the 3d and 4th premolars have one elevated transverse crest near their middle, and the second is much compressed. The first I cannot find. Symphysis rather short for the genus.

Measurements No. 2.	M.
Length superior molar series	0.085
" true molars	.046
" penultimate	.015
Width "	.019
Length inferior molar series	.078
" " true molars	.0475
" penultimate	.0170
Width "	.0110
" last premolar	.0080
Length " "	.0120
Depth ramus at last premolar	.0235
Length diastema	.0190
" of bases of three incisors	.0180

HYRACHYUS PRINCEPS. Marsh.

South Bitter Creek.

HYRACHYUS EXIMIUS. Leidy.

Cottonwood Creek, common.

HYRACHYUS AGRARIUS. Leidy. *Lophiodon bairdianus*. Marsh.

Common everywhere.

HYRACHYUS BOOPS. Marsh.

Bitter Creek, Black's Fork.

HYRACHYUS NANUS. Marsh.

Cottonwood Creek.

Published, March 8th, 1873.

NO. 13.

ON SOME OF PROFESSOR MARSH'S CRITICISMS.

BY E. D. COPE.

I.

I have already (in "The Short-footed Ungulata of the Eocene of Wyoming;" Naturalists' Agency, Salem, Mass.) shown, by figures and descriptions, the absence of foundation for Professor Marsh's recent animadversions, and though these latter present internal evidence of idiosyncracy which almost disarms reply, yet as some of the readers of this journal may not see the above essay, I make a few specific contradictions of some of his statements which may be regarded as serious.

In an article "On the Gigantic Fossil Mammals of the Order Dinocerata," he writes as follows:

"(1) What Prof. Cope has called incisors are canines, etc." I had determined and stated them to be canines, in the American Naturalist, previous to the appearance of this criticism.

"(2) The stout horns he described are not on the frontals but on the maxillaries." I was the first to determine these bones to be nasals, and find that in *Eobasileus pressicornis* they compose the inner face of the horns to the apex, while the maxillaries form the outer face.* It was on this species that my original determination was based. In the original specimen the middle portion of both nasals is wanting.

"(3) The orbit is not below these horns but quite behind them, and has over it a prominent ridge on the frontal." In *Loxolophodon cornutus* the naso-maxillary horn is largely above the orbit, and there is no superciliary ridge of the frontal.

"(4) The occiput is not vertical, but extends obliquely backwards, the occipital crest projecting behind the condyles." Prof. Marsh has been perhaps led into this error by the imperfection of the occipital condyles in his specimen. He does not appear to know that in life the head was directed obliquely downwards, so that the occipital crest was vertical as I described it in *Loxolophodon* and in *Uintatherium robustum*.

"(5) The temporal fossa is not small posteriorly but unusually large;" and "(7) the spine of the tibia is not obtuse but wanting," are frivolous; *vide* my descriptions, *l. c.*

"(6) The great trochanter of the femur is recurved, though Prof. Cope says not." It is flat, as in the elephants.

"(8) One of the species named by Prof. Cope, *Eobasileus furcatus*, is based on what he regards as portions of the nasal bones. The description, however, indicates that these specimens are merely the posterior horn-cores of well-known species." In the location of these cores Prof. Marsh may be correct, but demonstration is yet wanting. How "well-known" these species are to Prof. Marsh, will be evident shortly; and how they could be well-known to anybody else, may be determined by

*(See my paper, p 18). Professor Marsh has since contradicted the former statement flatly.

reference to his brief notices of a few of them published to the date of his writing.

Omitting notice of sundry insignificant questions raised in a postcript to the paper, as well as those which are more or less repetitions of criticisms already made, I pass to his denial of the possession of a proboscis to these animals. I retain my belief that they had such an organ, and refer to my essay above cited for the proofs. Leidy has suspected its presence in *Megaceratops*. He then says "(7th) the malar bone does not form the middle element of the zygomatic arch, but the anterior as in the tapir." It forms the middle element in *Loxolophodon*, as may be seen from my figures. Below, its maxillary support forms one-third of the zygoma, at the side a little less, and above, a narrow lamina of the malar extends nearly to the lachrymal.

"(9) The nasal bones are not deeply excavated at their extremities." They are excavated, etc., as I have described.

Now it is easy to see by an examination of Prof. Marsh's figures of *Uintatherium mirabile*, where all this blundering criticism comes from, and I have pointed out to him that this is the source of error. But Prof. Marsh evidently desires no such consideration from my hands, but "*mirabile dictu*," repeats his statements, as though the *Uintatherium* were a Rosinante, and the ninth commandment a wind-mill.

Professer Marsh asserts that I have reversed the positions of the tusks of *Loxolophodon*, placing that of the left side on the right, etc. This statement is not true, and I have carefully distinguished the sides in my description (Short-footed Ungulata, etc., p. 10). In my Plate 2nd, the inner side is not represented as the outer, as the inner surfaces of attrition are omitted, and the external represented. Like his other charges, this one results from a misapprehension. Having seen a photograph in which, for the assistance of the artist, the left tusk was taken on the right side, he at once concludes that my lithograph represents it in the same position.

There is no inaccuracy in my statement of dates of publication of Prof. Marsh's genera. I have never stated that the name *Tinoceras* was proposed August 24th, but that it was referred to the *Proboscidia* at that date. This name was published in an erratum on August 19th, but was never described until September 21st and then only by implication in the description of a species. *Loxolophodon* and *Eobasileus* were described August 19th and 20th, with separate diagnoses.

I am charged with giving an erroneous date to his communication of December 20th before the American Philosophical Society. This will also be found to be correct by reference to the report of my communication (Proceedings Academy Natural Sciences, January 14th, 1873).

Prof. Marsh's standard of honesty is however so high, that he seems to think it essential that in redescribing the objects of our studies, all errors of first work must be faithfully transcribed. In order as it were to enforce this view, he faithfully ignores corrections of their own work

published by both his contemporaries, laborers in the same field.* I will not imitate this course in my treatment of Prof. Marsh's writings, but will on the other hand, as in duty bound to the truth, correct my own whenever and wherever I have opportunity, always holding to the only tenable position, that no statement of scientific fact bears date other than that on which it was printed and published, no matter to what previous publication it may refer.

Having already gone into the discussion of the affinities of these animals, I run rapidly over the characters assigned by Prof. Marsh to a supposed new order *Dinocerea* (which he now spells as corrected *Dinocerata* . Those from the first to and including the fourth are entirely trivial; the last, which denies air cavities to the cranium is moreover untrue, as they exist in the squamosal region as I have stated. The fifth is not true of all the genera. The definitions from the seventh to the eleventh are of no weight whatever. As the twelfth, he gives "the very small molar teeth and their vertical replacement." This is precisely the state of things in the proboscidian *Dinotherium*, a form which Prof. Marsh has overlooked. The 13th and 15th, "the small lower jaw," and "absence of hallux" are of no weight if true; but the lower jaw has marked proboscidian features in the symphysis and teeth, and it is probable that some of the species had a hallux. The 16th, "absence of proboscis" is probably an error, certainly so for two of the genera. I have passed over the (6th) "the presence of large postglenoid processes," and (14th) "the articulation of the astragalus with both navicular and cuboid bones," as of some value. They are, indeed, the only characters of any wide systematic significance adduced by Prof. Marsh, since they point indubitably to the *Perissodactyla* and are common to all of the *Eobasileidæ*. Nevertheless they form but a slim basis of support for an order of mammals, especially when compared with the uniform testimony of proboscidian affinity derived from the structure of the posterior palatal and maxillary regions, the cranial expansions, cervical vertebræ, sacrum, pelvis, hind leg, hind foot scapula, fore leg, fore foot, and the concurrent evidence derived from dorsal and lumbar vertebræ, dentition and proboscis.

If Prof. Marsh desires to see an equal or greater degree of variation in dentition in an order of mammals, let him compare *Equus* and *Rhinocerus* among *Perissodactyla*, or *Bos*, *Moschus*, *Hippopotamus* and *Phacochœrus* in the *Artiodactyla ;* in the length of the nasal bones, *Delphinus* and *Squalodon* among *Cetaceo*, or *Homo*, and some of the lemurs; in the number of toes, *Felis* and *Mustela*, *Ursus*, etc., all members of the same orders.

I should be glad, on the principle of *De mortuis nil nisi bonum*, to commend our critic's remarks on the relations of this supposed order. But Prof. Marsh's ideas on classification are derived from unusual sources. The absence of incisor teeth no more relates these animals to the *Artiodactyla* than it relates the sloth to the same order. The presence of paired

*See Leidy, Proceedings Academy Natural Sciences, 1872, p. 241.

horns no more constitutes affinity to the ruminants than it does in the case of the "horned-toad."

They are simply an analogous development on a proboscidian basis. The few affinities which this group exhibits outside the *Proboscidia*, are to the *Perissodactyla*, as I was the first to show, and among these, to *Palæotherium* and *Rhinocerus*. As to the name "*Dinocerata*," I have been induced to use it in the sense of a suborder, but am now satisfied that even this use is uncalled for, and shall employ the family name *Eobasileidæ* instead. On equally good bases the camel and *Tragulus* should be erected into new orders.

Another critic less courageous than Prof. Marsh, since he hides under the ægis of the "Eds." has attacked (Am. Jour. Sci. Arts, 1872, 489) my statement of determination of the Cretaceous age of the Bitter Creek coal, citing five authorities as having previously made the same determination. I have shown (Proc. Acad. Nat. Sci., Phila., Jan. 14, 1873) that but one of these references relates to the region in question, and that the critic was ignorant of the geography or literature of the subject, or both. He, however, repeats (loc. cit., 1873, 231) that Mr. Meek "referred Dr. Hayden's collection from Bitter Creek at Point of Rocks to the Cretaceous," a fact I had previously pointed out, and adds that I am in error in asserting that Mr. Meek attached interrogation marks to all his Coalville determinations (200 miles west), as he cites two *Cardia* and two *Inocerami* as from Coalville and without the question. More careful examination would have shown my critic that the two *Cardia* and one *Inoceramus* are stated to be from localities remote from both Coalville and Bitter Creek.

But there is no indication in my original note of a design to ignore the useful labors of the gentlemen who have written on this subject; nothing was farther from my intentions, in so issuing an early notice of my own observations, than to ignore the opinions of Mr. Meek, with which I have become pretty well acquainted through pleasant association on the same geological survey. Had they been coincident with my own, I should have mentioned them, although unpublished. Mr. Meek will, however, soon speak for himself. It requires but a casual examination to show that the criticism is captious and uncalled for, and that its author is only playing aid to the champion above considered.

II.

I now turn to another subject, the raising of which is due also to Prof. Marsh. He has very commendably made himself acquainted with the literature of the authors who had previously written on these extinct *Proboscidia*, though not in time to prevent his redescribing some of the genera and species. But unfortunately he does not tell us all that he knows. He knows perfectly well that my descriptions antedate his by a month and more, and that he is posterior to Dr. Leidy, by two months at least. He is however not strong enough to state the nomenclature

accordingly, but endeavors to prove something else. In order to do this, he is willing to write (Amer. Journ. Sci. Arts, 1873, p. 114), "the dates on the papers (Aug. 20th and 22d) certainly do not represent those of actual publication;" and again (American Naturalist, 1873, p. 151) "no less than seven of Prof. Cope's papers are antedated, as the records of the society will show." Prof. Marsh is not careful to prevent the natural deduction from these statements, that the dates are fraudulent; though he well knows to the contrary, and disagreeable though it may be to the *mens conscia recti*, I am compelled to prove that such is not the case!

I therefore append testimonials from the proprietors and foremen of the printing establishment from which the essays in question were issued, and from my assistant who received and distributed them:—

PHILADELPHIA, *March 24th*, 1873.

Professor O. C. Marsh having stated in the "American Naturalist" (1873, p. 151) that some of the papers published by Professor Cope during the summer of 1872, and printed by us, bear dates "which do not represent those of publication" and that "at least seven of them are antedated," we hereby state that these dates are true, and that on the days stated from fifty to one hundred copies of these papers were delivered by us into the hands of Pendleton King and Stephen G. Worth, assistants of Professor Cope, except that on *Metalophodon*, which was issued to Professor Lesley.

McCALLA & STAVELY.

JNO. S. SCHEIDELL, *Foreman of Composing Room.*
JOHN DARDIS, *Foreman of Press Room.*

LOUISIANA STATE UNIVERSITY,
Baton Rouge, *March 24th*, 1873.

PROFESSOR E. D. COPE, *Academy Natural Sciences, Philadelphia:*

DEAR FRIEND:—On looking over my papers, I find that I have, among papers written by you, the following:—

On a new genus of *Pleurodira* from the Eocene of Wyoming, July 11, 1872.

On the Tertiary Coals and Fossils of Osino, Nevada, July 29th.

Descriptions of some New Vertebrata from the Bridger Group of the Eocene, July 29th.

Second Account of Same, August 3d.

Third " " " 7th.

On the Existence of Dinosauria in the Transition Beds of Wyoming.

Short notice of Species of Loxolophodon (misprinted Lefalophodon), Cope, near August 17th.

Notices of New Vertebrata from the Upper Waters of Bitter Creek, Wyoming Territory, August 20th.

Second Notice of Extinct Vertebrates from Bitter Creek, Wyoming, August 22, 1872.

These I brought with me from Philadelphia, leaving early in September, 1872.

I laid them aside during July and August, and am confident that the dates which I find on them, as above, correspond with the times I received them from the printer.

Your instructions were for immediate distribution, which I followed, using the list of names of persons to whom they were to be sent. Some received them very soon, others after a short delay, as suited convenience in mailing; and I think all were mailed by the 1st of September.

You are at liberty to use this letter if desirable. Very truly,

PENDLETON KING,
Professor of Natural History in the University of Louisiana.

I now add testimonials from some of the persons to whom the papers in question were sent, although I consider this part of the evidence as quite immaterial, that which has gone before being sufficient as to the date of publication. It is indeed not to be expected that persons will generally remember the exact dates at which printed matter has been received. Nevertheless in a few days after making inquiry I received the following :—

"Professor O. C. Marsh having stated in the "American Naturalist" (1873, p. 151), that some of the above papers were not published at the dates which they bear, and that "at least seven of them are antedated," I hereby state that most or all the above were received at my address or by me, at or near the dates printed on them, especially those of the summer months."

JAMES ORTON, *Prof. of Natural History in Vassar College*, POUGHKEEPSIE, N. Y.
JAMES S. LIPPINCOTT, CORNING, New York.
E. T. COX, *State Geologist*, INDIANAPOLIS, Indiana.
CHAS. M. WHEATLEY, PHŒNIXVILLE, Pennsylvania.
WM. C. KERR, *State Geologist*, RALEIGH, North Carolina.
JOSEPH SAVAGE, LAWRENCE, Kansas.
GEORGE DAVIDSON, *President of Academy of Sciences*, SAN FRANCISCO, Cal.
JOHN H. JANEWAY, M.D., *Post Surgeon*, FORT HAYS, Kansas.

I have also received letters from Principal Dawson of Montreal and Professor Mudge of the State Agricultural College, Kansas, stating that they received the papers, but did not keep exact account of the date of reception. Among many others to whom they were sent, I may mention Professors Seeley, Huxley, Gegenbauer, Peters, Hyrtl, Du Bocage and others in Europe, and Messrs. Gotch and Rijgersma in Australia and the West Indies respectively.

I also add that they were received at my address at Fort Bridger, and mostly forwarded by me promptly after the dates of distribution.

The little that interests students in this matter is the dates of publication of the essays in question. The dates of reading are of secondary importance and have been abandoned by naturalists generally as furnishing basis for nomenclature, so that Prof. Marsh's able criticism of the dates on the cover of the American Philosophical Society's Proceedings for 1872 may be regarded as purely antiquarian. The papers in question were, in fact, issued independently of the society, and almost always in advance of the time at which they were read before it.*

The first descriptive notice of the new genus and species of *Proboscidians* was published on August the 19th, and two other papers describing the species and genera in more detail were published on the 20th and 22d respectively. An account embracing the same facts was also read by Prof. Winchell before the American Association for the Advancement of

* But lest our bibliophile again charge me with fraud, let me here correct an error in the report of the proceedings of that society for August, 1872, in "Nature" for 1873, p. 335. Here it is stated that my first note on the Proboscidians was read on August 16th ; I hasten to say that this is an error probably derived from the wording of the note as published on August 19th, in which it was stated (without my knowledge) that "The Secretary announced that he had received from Prof. Cope," etc. This could only have referred to the last meeting preceding (on the 16th) ; but, in fact, it was not read until the meeting following (September 20th).

Science, which opened its sessions at Dubuque, on August 21st (or 23d), of which an abstract has, after great delay, appeared in the American Naturalist for March, 1873. Finally a description of *Eobasileus* appeared in the scientific column of the "New York Independent" for August 22d, 1872.* The papers published in Philadelphia were issued without my revision, and hence contain a few typographical errors which Prof. Marsh finds of great use to himself. But under the circumstances the number is surprisingly few.

I now present a table of the nomenclature of the three genera of *Proboscidia*, synonymy being in italics :—

MONTH.	AUTHOR.		
	Leidy.	Cope.	Marsh.
August, 1872. 1st.	Uintatherium described with one species. *Uintamastix* do.		
19th.		Loxolophodon described with three species.†	*Tinoceras* used in erratum, not described ; no species described.
20th.		Eobasileus described and one species.	
22d.		Loxolophodon again described with three species.	
24th.			*Tinoceras* named ; no description.
September. 21st.			*Tinoceras* described with one species described.
27th.			*Dinoceras* described with two species.

Though Prof. Marsh has published five papers and six notes on these animals, but one of his species has been so far partially described as to be of any use to science. Publishing of bare names‡ may constitute a caveat, but not an injunction, but in the present case the dates are too late. Hence the trouble. "*Heu quantus erat sudor*," etc.

In one of Prof. Marsh's late catalogues, he asserts that *Loxolophodon cornutus* and *Tinoceras grandis* are identical. If this be true, the latter

* Not having the number at hand, I write from a loose note.

† In this communication the name *Loxolophodon* was misspelled Lefalophodon. As Prof. Marsh finds some difficulty in adopting the former name, I can accept the latter, should he insist on it.

‡ See the rule "adopted and practiced by most students. In case of a genus there must be a definition giving the essential characters." From "Thorell's European Spiders," quoted in Wallace's Address before the Entomological Society, London, and by W. H. Edwards in "Entomological Nomenclature" in "Canadian Entomologist," 1873, p. 32.

name must stand as a synonym of the former, and *Tinoceras* be withdrawn from the synonymy of *Uintatherium*, where it might well remain so far as his description characterizes it. But if so, his statement that there are five superior molars must be altered, as the genus *Loxolophodon* possesses six. He has also stated that *Uintatherium robustum* possesses a small tubercle on one of the molars not found in *U. mirabile*, and bases a generic distinction between the species thereon ; for use he at last succeeds in defining the latter as a species only.

Perhaps, however, Prof. Marsh desires to impose upon scientific literature the numerous names he has proposed for species he has never described.* This he has attempted in the case of the fossil American Turkey, *Meleagris superbus*, Cope, which was described by the writer over a year sooner than by him. At the latter date this species was discovered to have been called *M. altus*, Marsh, some months prior to my description, but without any allusion to its characters or other means by which it could be identified. If Prof. Marsh desires students to use his museum labels, without descriptions, he might refer to Bronn's "Lethæa Geognostica," and other works, where he will find all such names consigned to the rubbish of synonymy so soon as it can be ascertained to what they refer.

Since the above was written, Prof. Marsh has published charges respecting "breach of promise" to send papers, etc. As "it is a bad rule that does not work both ways," shall I question the dates on Prof. M.'s papers because I did not receive them until December? It would receive more of the *frons aenea* than I possess for such an enterprise.

To sum up the matter, it is plain that most of Prof. Marsh's criticisms are misrepresentations, his systematic innovations are untenable, and his statements as to the dates of my papers are either criminally ambiguous or untrue. I might now characterize the effrontery of these proceedings, by saying, that for the first time in the history of American Science has politics raised its hydra head, as those connected with the Geological Survey of the Territories, etc., are aware. Hence it is, that the recklessness of assertion, the erroneousness of statement, and want of appreciation of both ordinary ethics and scientific jurisprudence exhibited by these attacks are simply unparalleled. The incapacity of their author, of comprehending our relative positions, render further discussion of the trivial matters upon which we disagree unnecessary ; and the time thereby diverted from scientific pursuits being only lost, he will receive no further personal notice from the present writer.

N. B. The reader is requested to compare Prof. Marsh's criticisms with my plates published in "The Short-Footed Ungulata of the Eocene of Wyoming."

* Several of which owe their existence in literature to the descriptions which I have given, *e. g.*, *Thecachampsa squankensis* "Marsh," *Hadrosaurus minor* "Marsh."

PALÆONTOLOGICAL BULLETIN.

NO. 14.

ON SOME NEW EXTINCT MAMMALIA, FROM THE TERTIARY OF THE PLAINS.

By Edward D. Cope.

Aelurodon mustelinus, sp. nov.

A small single-rooted second molar of the lower jaw. First molar sectorial, with a rather narrow posterior heel, one-third its length, and a small inner tubercle at the base of the second outer cusp. Last premolar with a short posterior heel and distinct outer tubercle on the posterior side of the cusp. Margin of jaw strongly everted below the masseteric fossa.

	M.
Length of three last molars	.018
" " sectorial "	.010
Width " " " (greatest)	.005
Height posterior cusp, do	.005

This species was about as large as the domestic cat, and less than one-third that of *Ac. ferox*, Leidy.

Aceratherium megalodus, sp. nov.

Represented by a perfect cranium with dentition of both jaws nearly complete, with large portions of skull and dentition with other bones of other specimens.

The nasal bones are not coössified, and but little little convex. They are smooth, and long and slender, indicating that this rhinocerus was without a horn. The inion is anterior to the line of the occipital condyles and is considerably elevated and bilobed. The temporal fossæ approach each other, being separated by a narrow rib only. The ramus mandibuli is rather slender, and projects well in front of the line of the nasals. The dentition is I. $\frac{?}{2}$; C. $\frac{0}{0}$; P. M. $\frac{3(-4)}{3}$ M. $\frac{3}{3}$. The usual anterior premolars are wanting in the lower jaw, and in the upper jaw in one specimen, and on the right side of the other ; hence I suspect $\frac{3}{3}$ to be the normal dentition of the species, are $\frac{4}{4}$ in *Rhinoceros* and *Aceratherium*, the present animal may be placed in another genus under the name of Aphelops. The middle incisors were cardicous. The outers are very large and cylindric at base ; the attrition of their inner faces would indicate an opposing pair, but these I did not find, and the premaxillary sutures of the maxillary are exceedingly slender.

The first lower premolars are not very narrow. The transverse crests of the superior molars widen inwardly, but do not come into contact with each. On the posterior margin of the posterior is a deep notch which almost divides it across. There are no other lobes. The last molar is narrowed. These teeth are notable for their very large size, as

compared with that of the skull generally. In one specimen P. M. 2 (the anterior) is .8, the second molar in transverse diameter, but in another specimen it is less than half the same.

	M.
Length molar series	.255
" second molar, crown	.050
Width " " "	.050
" " premolar "	·033
Length " "	.032
" first (2d) lower premolar	.028
Width " " " "	.076
Total length cranium	.560
From inion and to end nasals	.456
From foramen magnum to inion	.138
Width at orbits	.173
Depth mandible at first molar	.070

About the size of the Indian *Rhinorcerus*, but with much larger teeth.

Published July 25, 1873.

PALÆONTOLOGICAL BULLETIN.

NO. 15. —— & No. 16

SECOND NOTICE OF EXTINCT VERTEBRATA FROM THE TERTIARY OF THE PLAINS.

BY EDWARD D. COPE.

Rodentia.

PALÆOLAGUS AGAPETILLUS, sp. nov.

Molar teeth six ; the first of a single column, the others of two, anteroposteriorly arranged, each surrounded by its distinct enamel sheath, with a narrow intervening band of cementum. Posterior molar much reduced in size ; posterior column of molars with a median posterior rib, which forms a loop in section. Anterior column much more elevated than posterior. The section of the slender incisor is nearly a right-angled spherical triangle.

	M.
Length of molar series	.0100
" penultimate molar	.0020
Width " "	.0020
Depth jaw at " "	.0065
Diameter incisor	.0015

Size a little greater than that of the *Sagomys princeps.*

COLOTAXIS CRISTATUS, sp. nov.

Order Rodentia, Char. Gen. Inferior molars 3 ; crown plicate, with two connected cusps with crescentric section, on the outside, each of which gives rise to two transverse crests, which are unconnected. Of these crests the anterior and posterior are marginal and less developed than the median pair. Intervals deep, without cement.

Char. specif. Anterior molar narrower than the others, the cusps partly alternating, the connecting crest of the exterior wall internally placed, the transverse crests from the posterior forming a V. Anterior cusps well separated. Enamel of all the molars smooth.

	M.
Length of molar series No. 1	.0110
" penultimate molar	.0037
Width " "	.0030
Length of first "	.0033
Width " "	.0025

Second and third specimens display the incisor, whose outer anterior faces form a regular convex.

HYRACODON QUADRIPLICATUS, sp. nov.

Represented by four superior molar teeth of one maxillary bone, and two from the other, with several fragments. The transverse crests are

little curved, and the outer elevated crest, uninterrupted. A short elevated fold proceeds from the latter, dividing the head of the transverse valley. A compressed conic tubercle stands between the inner extremities of the crests. The first premolar has two transverse crests and an anterior tubercle. The posterior crest is strongly curved backwards at its inner end. A strong cingulum surrounds the base of the crown except on the outer side.

Measurements.

	M.
Length of three anterior molars	.090
" third molar	.030
Width " "	.033
Length of first "	.026
Width " "	.019

This species is twice as large as the largest known species of the genus.

HYRACODON ARCIDENS, sp. nov.

Established on the premaxillary and molar dentition, as far as the fifth tooth of the left upper jaw. The species is intermediate in size between the two last, but is nearer in this and other respects to the *H. tapiranus*. The molars have the outer longitudinal and inner transverse crests, the posterior short, the anterior much curved backwards round it, and thus forming the inner boundary of the tooth wall. The first premolar is shorter than the others and has a short anterior lobe. The milk molars show more nearly transverse crests as in *Rhinocerus*, but the first premolar had the anterior lobe. Canine and first incisor short, conic; second incisor with an outer lobe; median incisor transverse. Enamel smooth.

	M.
Length of four superior molars	0.072
" diastema	.006
" canine and incisors	.020
" first premolar	.014
Width " "	.012
Length of third "	.021
Width " "	.022
Height " "	.025

Portions of two or three individuals found.

SYMBORODON TORRUS. Gen. et sp. nov.

The horned mammals of the present period are, as is well known, the *Artiodactyla*. In the discovery of the genera *Loxolophodon*, *Eobasileus*, etc., I was afforded opportunity of showing that the horned types of the Eocene were Proboscidians of an aberrant type. The present notice introduces a series of forms from the Miocene with a familiar armature of osseous horns, which are all true Perissodactyles, and allied to the

Rhinoceros and *Palæotherium*.* The present genus is established on mandibular rami only, which cannot be certainly associated with crania.

Char. gen. Dentition : I. ? 0 ; C. 1 ; Pm. 3 ; M. 3 ; the canines slightly separated from each other, but not from the first premolar. Crowns of the premolars with L-shaped crescents as in *Rhinoceros* ; of the molars with completed crescents ; the last molar with third posterior crescent. Symphysis mandibuli coössified ; crowns of canines not projecting, conic.

Char. specif. Symphysis oblique, ramus rather shallow. Last molar with three columnar ribs on the outer side, four on the inner, produced by the continuance inwards of the ridges from the anterior and posterior outer cusps. Enamel nearly smooth ; a cingulum round inner basis of crown of canine.

Measurements.

	M.
Length mandibular ramus	.520
" symphysis	.144
" series of molars	.320
" " true molars	.215
" last molar	.088
" penultimate do.	.072

The genus differs from *Titanotherium* and *Brontotherium* in the absence of incisors, and from the former in the presence of but three premolars. If there had been a deciduous incisor on each side I was unable to detect any trace of it.

MIOBASILEUS OPHRYAS. Gen. et sp. nov.

Established on a cranium with nearly complete dentition, but without mandibular ramus. Head elongate, concave in profile from the interorbital region to the supraoccipital crest. This is transverse and concave, the posterior borders of the temporal fossæ extending behind it. These fossæ leave a narrow flat vertex between them. Zygomatic arch stout and rather deep ; a strong postglenoid process. Nasal bones very massive, their free portion elongate, hornless. A massive horn-core rising from above each orbit, no superciliary angle or ridge. Orbit not enclosed behind. Of molar teeth only Pm. 2, M. 3, preserved, the M. with two, the Pm. with one inner cone, and two outer continuous crescents. The latter send inwards to one side of the cones a transverse ridge. Incisors and canines unknown.

Char. specif. Front concave transverse just behind between the horns. Latter massive and little compressed. Nasal bones convex longitudinally and transversely, slightly rugose. Transverse ridges of teeth with transverse expansions at their inner extremity being thus T-shaped.

* Leidy and Marsh have described two genera of this group, viz., *Titanotherium* and *Brontotherium*, but without certain indication of their possession of horns.

Measurements.

	M.
Length from apex of nasals to occipital condyles (axial) (thirty-four inches)	.684
" from occipital condyles to femoris of palate	.376
" " occipital condyles to end of palatine lamina pteryzoidea	.270
" of four last molars	.242
" three "	.195
" last molar	.068
Width of palate at nareal notch	.116

This remarkable mammal shows several points of approximation to the *Rhinocerotidæ* as compared with others of the same group. Its physiognomy is also a remarkable parallel of the *Loxolophodon cornutus*, Cope, of the Eocene, which animal it did not equal in size, although it exceeds the largest living *Rhinoceros*. Two specimens of crania seen.

MEGACERATOPS ACER, sp. nov.

Another huge mammal, second only to the preceding in size, but more formidably armed, was its cotemporary. It is represented in my collection chiefly by a single cranium without under jaw. Top of head flat, forming a narrow plane between the temporal fossæ; latter produced backwards. Orbit not enclosed behind, an overhanging superciliary ridge. Nasal exceedingly short and massive, each supporting a large acute horn-core, which is connected with its fellow by a ridge at the base, and diverges widely from it with an outward and forward curve to the acutely compressed apex. Each horn-core about one foot long. The top of the head is plane between the orbits, and little concave fore and aft. The zygoma is very deep, and the postglenoid process well developed. End of nasal bones short and thick, but flat.

Measurements.

	M.
Length cranium (thirty-five inches)	.895
" from posterior rim temporal fossa to middle of superciliary ridge	.345
Width front between eyebrows	.210
Length horn-core on inner side (10 in.)	.254

The elemental origin of the horn-cores is probably different in this genus from that which exists in *Miobasileus*.

This was a truly formidable beast, exhibiting a position of the horns strangely the reverse of that seen during the present period. Its size exceeded that of the Indian Rhinocerus.

MEGACERATOPS HELOCERUS, sp. nov.

Founded on a cranium of an animal of larger size than the last, with nearly complete maxillary dentition. There is a prominent horizontal superciliary ridge without horns, and two short obtuse horn-cores on the

muzzle. These diverge outwards, the outer sides being flattened and the summits contracted and truncate. They are mere rudiments of the horns seen in *M. aceronsor*, *M. coloradoensis.* The molar teeth do not exhibit the T-shaped cross-ridges seen in *Miobasileus*, and the two outer crescents are continuous with each other.

Measurements.

	M.
Length from posterior rim of temporal fossa to middle of osseous eyebrow	.472
Least width of parietal plane	.104
Superciliary width	.260
Elevation of horn-core	.050

The premaxillary region of this specimen was destroyed, so that no account of the anterior dentition can be given.

Of the horned *Perissodactyla* four species are described above, but there is little doubt that they represent but three. The lower jaws of the genus *Symborodon* pertain to the cranium of one of the species referred to *Miobasileus* or *Megaceratops*, but to which, it is impossible to state at the present time. Opportunity for solving this point will no doubt soon occur. All of these species are abundantly distinct from the *Megaceratops coloradoensis*, Leidy. Known from a fragment of the snout.

As to the generic distinctness of the two genera here proposed, it is obvious that *Miobasileus* is distinct from *Megaceratops*, but whether *Symborodon* be so, is not determinable. Until the dentition of that form be known, its relations both to *Symborodon* and *Brontotherium* will remain in uncertainty.

The two genera of the formation in question correspond with those described last summer from the older period, thus :

Horn over orbit,

Miobasileus.	*Loxolophodon.*

Horn anterior to orbit,

Megaceratops.	*Uintatherium.*

Reptilia.

PELTOSAURUS GRANULOSUS. Gen. et sp. nov.

Order *Lacertilia.* Premaxillary undivided, with spine ; a parietal fontanelle and parieto-quadrate arches. Teeth pleurodont, with obtuse compressed crowns, of similar form on all the jaw bones. Body covered with osseous scuta, which are in places united by suture. Vertebræ depressed, with simple articulations. Median hexagonal dermal scuta on the parietal bone. Parietal united.

Char. specif. Parietal bone broad and flat, frontal little narrowed, gently convex, both with finely granular upper surface. Scuta not keeled, finely granular. Number of teeth on premaxillary bone seven ; teeth on dentary ten in M. 010. Surfaces of dentary smooth.

	M.
Median width of parietals	.014
" " frontals	.008
Length mandibular ramus to cotylus	.040
Diameter vertebral centrum (transverse)	.003
Length " "	.0055

Size about that of the American *Heloderma.*

The genus is allied to the *Glyptosaurus* of Marsh.

TESTUDO CULBRATUS, sp. nov.

This species introduces several from the same formation as the *Peltosaurus,* which agree with the existing genus *Testudo* in their short, stout metapodal and phalangeal bones, and single anal scutum of the carapace.

In the present species the prominent peculiarity is seen in the form of the hip of the anterior lobe of the plastron, each half of which is an elongate pyramid, its depth and width being equal. The marginal bones were short, stout and recurved ; length of carapace nearly 18 inches.

TESTUDO LATICUNEUS, sp. nov.

In this species the anterior hip of the lobe of the plastron is very prominent and wedge-shaped, and with dentate margin, and is flat and thin. The posterior lobe is sub-truncate. The mesosternal bone is hexagonal and broader than long, and is pointed behind. The pygal bone is triangular and the anal marginal is convex in both sections and abbreviated below. Each marginal bone behind the bridge presents a mucro where a dermal suture reaches the margin. Anal scutum very wide. All the sutures double lines. Length from eighteen inches to two feet ; width two-thirds of the length. Carapace rather flattened.

This is the most abundant species of the formation; several good specimens obtained.

TESTUDO AMPHITHORAX, sp. nov.

Anterior lobe of plastron broadly truncate, scarcely lipped ; posterior lobe openly emarginate. Mesosternum longer than broad, acute in front, very obtuse behind. All the sutures simple. Anal marginal shortened but convex. Form depressed. Length and width as in the last.

TESTUDO LIGONIUS, sp. nov.

Posterior lobe of plastron produced into two flattened sharp-edged, wedge-shaped processes separated by a deep notch, as in *Hadrianus corsonii.* Marginal bones behind very wide, or considered separately, long and narrow, with a step-like angle and notch where the scutal suture reaches the margin.

The form of the anterior lobe of the plastron is yet uncertain, though fragments found with the type, resemble that of *T. laticuneus.* At least those incomplete specimens obtained.

Issued August 20, 1873.

NO. 16.

THIRD NOTICE OF EXTINCT VERTEBRATA FROM THE TERTIARY OF THE PLAINS.

BY EDWARD D. COPE.

Insectivora.

DOMNINA GRADATA. Gen. et sp. nov.

Represented by a portion of the right mandibular ramus with three entirely preserved molars. These teeth increase in size regularly from behind forwards, so that the anterior is relatively large; there are no indications of alveoli anterior to this one, but a considerable internal canal rises in front of it, and the mental foramen issues below it. The crowns of the molars are composed of two rows of alternating tubercles with an odd one in front. The inner tubercles are much the more elevated and form the apices of Vs, of which the inner commence the limbs.

Char. specif. Three rows of acute tubercles on the inner, two on the outer side of each dental crown, the last pair of the last crown fused into a heel; the middle inner and anterior outer forming together a notched yoke. A low cingulum on outer, none on inner basis of tooth crown; enamel smooth.

Measurements.

	M.
Length of basis of three molars	.0055
" " first "	.0023
" " last "	.0015
Depth of ramus at first molar	.0026
Width of first molar	.0015

HERPETOTHERIUM FUZAX. Gen. et sp. nov.

Established on a left mandibular ramus incomplete at both extremities, but exhibiting the crowns and alveoli of five molar teeth. These diminish in size anteriorly, and there is no anteriorly exposed canal or alveolus, and there is no mental foramen visible. The crowns are composed of two rows of tubercles, but the inner are low and sometimes obsolete, and there is an anterior lobe. The inner lobes are much the higher.

Char. specif. Enamel smooth, no cingulum on either side. Molars truncate behind. Outer anterior lobe acute, considerably the higher.

Measurements.

	M.
Length of bases of four molars	.0070
" " second "	.0020
Width " " "	.0012
Depth of ramus at " "	.0030

This species and the last were about the size of our mole, and no doubt possessed similar insectivorous habits.

DAPTOPHILUS SQUALIDENS. Gen. et sp. nov.

General character of dentition as in *Machaerodus*, but the mandibular teeth are L. 1; Pm. 3; M. 1; a premolar tooth being added. Second premolar three lobed; carnassial tooth with short cutting heel; tubercular none. Superior canine much compressed, denticulate, not grooved.

Char. specif. Third premolar with the anterior basal tubercle very large, equalling, relatively, the corresponding lobe of the carnassial (much smaller in *Dinictis felina*). Second premolar two-rooted. Enamel smooth. Ramus decurved at symphysis. Superior canine in shape like a tooth of a shark of the genus *Oxyrhina*; flat within, slightly convex without; the front cutting edge turned inwards at the basis.

Measurements.

	M.
Length basis of three posterior molar teeth..........	.040
" " second " "	.010
Elevation crown " " "	.009
Length " fourth " "	.017
Elevation " " " "	.013
Depth ramus at " " "	.015
" " second " "	.018
Length fragment upper canine........................	.025
" " " " at base................	.011

Size of the Panther

TOMARCTUS BREVIROSTRIS. Gen. et sp. nov.

Established on a mandibular ramus supporting a perfect carnassial tooth and fangs of the following dentition: C. 1; M. 4; the last incomplete, hence the number of posterior teeth unknown. The ramus is much narrowed in front. The carnassial has an inner tubercle behind the median lobe, and a large posterior heel supporting both inner and outer tubercles. The succeeding tooth was wide.

Char specif. First premolar one, second two-rooted. Anterior half of the carnassial with the usual sectorial structure, the anterior lobe the smaller. The inner tubercle about the same height. The heel constitutes one-third the length of the tooth, and its lateral tubercles are angular, the posterior low. Enamel slightly rugose.

Measurements.

	M.
Length of first three molars........................	.041
" third molar (carnassial)....................	.023
Elevation " "	.014
Width " " at middle................	.009
Length of heel do.	.007
Depth ramus at do.	.021

In the abbreviation of the dental series in front, this species resembles the Feline group, while its expansion behind and the tubercular charac-

ter of the carnassial tooth reminds me of bears. The species resembles the black bear in the size of the mature molars.

STIBARUS OBTUSILOBUS. Gen. et sp. nov.

Represented by a portion of a mandibular ramus which supported the three anterior premolars. The form of the last indicates that it immediately preceded the sectorial, so that the series numbered one less than in *Canis*, to which the genus appears to be allied. The teeth are elongated and compressed with low crowns and flattened roots; the crown of the third is four-lobed.

Char. specif. Thin premolar with large anterior lobe and posterior heel. Median lobes obtuse; three last lobes connected by a low edge. Enamel slightly rugose.

Measurements.

	M.
Length bases of three premolars	.016
" " third "	.008
Elevated crown " "	.004
Depth ramus at " "	.007

CANIS GREGARIUS, sp. nov.

Abundant in the *Oreodon* beds of the Miocene formation, and about the size of the red fox. First premolar one-rooted, second molar two-rooted and with two transverse tubercles. Fourth premolar with median and basal lobes, forming a cutting edge in line. Sectorial with stout inner tubercle and short heel.

	M.
Length molar series	.036
" premolar "	.019
" fourth premolar	.006
" sectorial	.009
Width "	.004
Height "	.006
Depth ramus at sectorial	.010

A second and larger species occurs with the preceding.

ISACUS CANICULUS. Gen. et sp. nov.

Established on a mandibular ramus with two molars including the sectorial, which is illustrated by a similar specimen with two posterior molars. The genus has three tubercular molars, of which the two anterior are composed of two elevated cross-crests, which form partial Vs, opening to the inner side. The sectorial supports three anterior conic tubercles, the inner and outer equal, and a heel with a conic tubercle on the outer side.

Char. specif. Tubercular teeth with anterior limbs of Vs much shorter than posterior, the posterior connecting the longer limbs. A cingulum in front only. Lobes of sectorial acute, anterior and posterior lower, sub-equal.

	M.
Length sectorial and two tuberculars	.0210
" " alone	.0045
Width "	.0020
" first tubercular	.0030
Length " "	.0032
Depth jaw at do.	.0060

This genus differs from *Amphicyon* in the large development of the internal tubercle of the sectorial and in other points.

Rodentia.

PALÆOLAGUS TURGIDUS, sp. nov.

The largest species of the genus. Molars with two simple columns, the first and fifth grooved on the outer side only, the interior grooves of the others weaker. A porous enlargement on the inner inferior part of the ramus just behind the symphysis. Diastema obtuse.

Measurements.

	M.
Length of molars	.016
" three median	.010
Depth ramus at central	.011
Width central tooth	.0035
Length three central molars in a second specimen	.0115

Larger than *P. haydenii* and still larger than *T. agapetilla.*

PALÆOLAGUS TRIPLEX, sp. nov.

Size of the last; first and last molars deeply grooved on both sides as well as all the rest; first molar with a trifolium-lobate crown. Median three molars with a narrow posterior column as in *P. agapetillus.* Punctate patch on inner face of ramus extensive.

	M.
Length molar series	.016
" median three molars	.010
Width of median molar	.003
Depth ramus at " "	.011

This species and the last are rather larger than the prairie marmot (*Cynomys ludovicianus*).

The superior dentition in this genus is I. 2; C. 0; M. 5. The molars are fissured on the inner side in all the species, and on the outer also in one of them.

TRICIUM AVUNCULUS. Gen. et sp. nov.

Char. gen. Inferior molars ? 4, the first composed of three columns, well rooted. Otherwise as in *Palæolagus.* The larger species referred to this genus may possibly have five inferior molars, a point I cannot now decide. The first molar is more distinctly rooted than in *Lepuso* and I suspect that the present genus has, like *Palæolagus,* not more than five superior molars.

Char. specif. Size very small. The molars, except the first, with a distinct but narrow posterior third column, their sides grooved nearly to the centre. Incisor sub-triangular in section.

Measurements.

	M.
Length of anterior three molars	.0066
" first molar	.0024
Width " "	.0018
Depth ramus at first molar	.0060

Other specimens are a little smaller than the above.

TRICIUM LEPORINUM, sp. nov.

This species is larger than the last, and the molars lack the posterior column which it possesses. The first molar is narrowed in front, and is not grooved to the base on either side; the second is grooved to the alveolar wall on the inner side only, the others on both sides.

Measurements.

	M.
Length of anterior three molars	.0076
" first molar	.0025
Width " "	.0020
Depth of ramus at first molar	.0070

Tricium agapetilla is allied to this species; I originally referred it to *Palæolagus* (see Bulletin No. 15).

TRICIUM PANIENSE, sp. nov.

This species is similar in the dentition of the anterior part of the jaw to the last species, but is quite distinctly larger, as the following measurements explain. The region of the diastema is quite stout, and the incisor convex on the anterior face.

Measurements.

	M.
Length of two anterior molars	.0068
" first molar	.0032
Width " "	.0021
Depth ramus at first molar	.0085
" " diastema	.0061

GYMNOPTYCHUS CHRYSODON. Gen. et sp. nov.

Char. gen. The essential features are, dentition; I. $\frac{1}{1}$; C. $\frac{0}{0}$; M. $\frac{5}{4}$; the molars with two crescents on the inner side above, each of which gives rise to a cross-ridge to the outer margin. In the mandibular series the crests and crescents have a reversed relation. No cementum.

Char. specif. First upper molar a single cone. Incisors quite compressed. First inferior molar a broad oblong, the cusps opposite, the anterior close together. The two posterior cross crests do not form a V, the anterior being interrupted at the cusp. There is a delicate tubercle

between the outer cusps of the three last molars. The incisor is compressed, the anterior and outer faces being separated by an angle.

	M.
Length of molars	.0140
" penultimate molar	.0033
Width " "	.0035
" first molar	.0030
Length " "	.0035
Depth jaw at penultimate do.	.0090
" incisor tooth	.0040
Width " "	.0020

The skull is broad and stout but not depressed ; muzzle broad above, short. Front moderately contracted, no postorbital processes.

GYMNOPTYCHUS NASUTUS, sp. nov.

Much smaller than the last. Inferior molars with two cross-crests and two cingular from the external cones, each posterior crest of a pair terninating in an interior cone. First molar narrower. The anterior part of a cranium probably belongs to the same species. The first molar has a sub-round crown with four tubercles ; the second is constructed like the corresponding inferior. Muzzle much compressed, nasal bones flat, extending to beyond above incisors.

Measurements.

	M.
Length anterior three molars	.0045
" first molar	.0015
Diameter inferior incisor	.0008
Depth ramus at second molar	.0036
Length diastema above	.0080
Width at pre-orbital region	.0073
" end of muzzle	.0030

GYMNOPTYCHUS TRILOPHUS, sp. nov.

Ramus depressed, elongate. Molars with two outer crescents separated by a deep notch, each of which gives rise to a single cross-crest, an anterior and posterior, without cingula. The inner apices of the crescents unite and give origin to a short median cross-crest.

Measurements.

	M.
Length four molars	.0070
" second "	.0017
Width " "	.0015
Depth ramus at second molar	.0035
Width of lower incisor	.0010

GYMNOPTYCHUS MINUTUS, sp. nov.

A very small species. Middle pair of molars with the anterior and posterior cross-crests bifurcate, and a short median cross-crest. Only

three cross-crests on the fourth, and four tubercles on the first. Ramus deep.

Measurements.

	M.
Length of inferior molars	.0040
" second "	.0010
Width " "	.0010
Transverse diameter incisor	.0008
Depth ramus at second molar	.0030

Scarcely larger than the house mouse.

Perissodactyla.

ANCHITHERIUM CUNEATUM, sp. nov.

Represented by the superior molar teeth of several individuals one-third smaller than those of the *A. bairdii.* The prominent peculiarity consists in the anterior production of the anterior external cusp anteriorly, giving a wedge-shaped outline to that part of the tooth. The first premolar is quite small. The fore and aft cingula are well developed, and the basal parts of the transverse ridges are partially separated into tubercles, the posterior one sending a low ridge backwards.

Measurements.

	M.
Length of M. 2 and 3 of No. 1	.0260
" M. 1 "	.0130
Width " "	.0110
Length of Ms. 1–4, No. 2	.0410
" M. 2 "	.0115
Width " "	.0130

Artiodactyla.

LEPTAUCHENIA CALCARATA, sp. nov.

Established on a superior maxillary bone which supports Pm. 3 and 4, and M. 1, 2 and 3 in perfect preservation, and probably by other remains.

The species is characterized by the presence of an additional narrow column with acute apex behind the posterior outer crescent. A similar cusp exists in front of the anterior cusp, as in other species. The third premolar is little longer than the fourth, and the inner cusp is very small.

Measurements.

	M.
Length of five molars	0.0260
" three true molars	.0175
" last " "	.0080
Width " " "	.0070

This species is smaller than the smallest of the genus yet described.

Leptauchenia minima, sp. nov.

Represented by numerous remains of a species not larger than a gray squirrel.

The antero-exterior vertical ridge is more prominent, and overlaps the preceding tooth more extensively than in the other species. The posterior superior molar is narrowed behind, and has a small heel column. In the mandible the third premolar is three-lobed, and the first premolar is not separated from the second by a hiatus. Enamel smooth. The valleys of the anterior lower molars disappear with use more frequently than in some of the allies.

Measurements.

	M.
Length of true molars above (No. 1)	.0120
" last "	.0050
Width " "	.0030
Length three inferior posterior molars (No. 2)	.0130
" " last molar	.0058
Width " " "	.0025

Probably the least known species of Artiodactyle.

Trimerodus cedreusis. Gen. et sp. nov.

Char. gen. Molars constructed as in *Leptauchenia;* the last premolar three-lobed externally, internally with one, a posterior lobe. Exterior ribs prominent.

Char. specif. First true molar with anterior and posterior cingulum, and with the inner crescents more elevated on the anterior limb. Last premolar with a broad cingulum within the two anterior lobes.

Measurements.

	M.
Length first molar	.0060
Width " "	.0055
Length last premolar	.0070
Width " "	.0040

Size equal to that of *Leptauchenia calcarata.*

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PALÆONTOLOGICAL BULLETIN.

NO. 17.

FOURTH NOTICE OF EXTINCT VERTEBRATA FROM THE BRIDGER AND THE GREEN RIVER TERTIARIES.

By Edward D. Cope, A.M.

Eobasileus galeatus. Sp. nov.

Represented by the greater portion of a cranium of an individual of the size of the Loxolophodon cornutus. It possesses a greatly elevated occipital crest, whose superior border presents a median angle upwards. A short distance in front of it and connected by a very stout lateral ridge, there arises on each side a large erect horn-core. The base is very massive, subquadrate in section, and flattened in front. Posteriorly it presents a very shallow groove, which is bounded on the outer side by a low ridge. The shaft expands gradually and is proportionally flattened from behind forwards. The posterior face is flat, the anterior gently convex. The extremity is transverse convex, and fitted for cartilaginous or corneous attachment. These horns stand on the parietal bones. The frontals extend to their bases, and send a laminar expansion backwards to the margins of the lateral and posterior crests, covering the parietal in the fundus of the basin which the former enclose.*

The median horns are very stout, and are connected with the posterior by an acute supratemporal ridge. Their inner face is composed to near the apex by the nasal bones. Where they terminate, the apex contracts, and is composed of a cylindric production from the maxillary. The section of these cores at the middle is subquadrangular, and longitudinally oval at base.

The extremity of the nasal bones is small and contracted, and is extensively overhung by the cornice-like flat cores above them. Thus the end of the snout has a bilobate outline when viewed from above.

The occipital face is concave in vertical section and presents a V-shaped depression with the angle downwards, and a low ridge on the middle line to the transverse superior border.

Measurements.	M.
Width of the foramen magnum and occipital condyles.	.2100
Elevation of occiput (eight in.)	.2500
Width of basin between lateral crests	.3250
Height of posterior horn-core (seven in.)	.2300
Width base do. antero-posteriorly	.1300
" " transversely	.0900
" of summit	.1230
Height of median horn-core	.1750

* Marsh originally stated that these horn-cores in *Uintatherium mirabile* stand on the frontal; but later that it was doubtful whether the frontal supported horns.

Measurements.	M.
Diameter of base antero-posteriorly	.1060
" " transversely	.0800
" of summit	.0650
Projection of nasal cornice beyond apex	.0630
Length posterior molar, crown	.0450
Width " " "	.0550

This species is equal in size to the largest known from the Bridger formation. It differs from *Eobasileus* (*Loxolophodon*) *cornutus* in the angulate base of the posterior horn-cores, the acute supra-temporal ridge, the stoutness of the median cores, and extent of their inner face, covered by the nasal bones, and the relatively greater width of the second true molar. It much more nearly resembles the *Eobasileus pressicornis*, Cope, and may possibly prove to represent an old male of that animal. There is, however, a considerable disparity in their sizes; the horns differ in the greater stoutness, having twice the diameter, with little greater height. They differ also in form and in the abrupt contraction just below the apex. The cornice-like cores of the nasal bones represent the tubercles of the *E. pressicornis*. The posterior horns differ in many ways from those of the *E. furcatus*, and are alone sufficient to indicate a different species.

From the bad lands of South Bitter Creek.

ARCHAENODON INSOLENS. Gen. et sp. nov.

Char. Gen. Dentition of mandible. In. 3; C. 1; P. m. 3 (? 4) M. 3; forming an uninterrupted series throughout. Molars consisting of two pairs of obtuse tubercles, those of each pair fused transversely by a lower yoke. Last molar with a large posterior fifth tubercle. Last premolar enlarged, and with a posterior heel; penultimate with a simple conic crown and two roots. It is uncertain whether one or two teeth intervene between this one and the canine. The alveoli are round, and look as though designed for two single-rooted premolars.

This genus presents many points of resemblance to *Elotherium*, but the continuous dental series is characteristic of many genera of the Eocene. In the only known species there are no osseous tuberosities on the rami. The symphyseal suture is persistent.

Char. specific. Last premolar with longer basis than first molar; its posterior heel tubercularly plicate. The crown of the penultimate premolar is a slightly compressed cone with elongate base, but little shorter than that of the first molar. Molars with smooth enamel; an anterior cingulum on the second and third. A small posterior median tubercle on the second molar, and a short cingulum from the base of the posterior cone forwards, on the third. Canines very large, sub-erect, enamel smooth. Ramus of mandible very stout.

Measurements.	M.
Length of molar series	.180
Diameter of canine tooth	.033
Length of premolars	.093
" " No. 3	.035
" molar No. 1	.024
" " No. 2	.027
Width " —	.022
Length " No. 3	.041
Width " "	.024
Depth ramus at molar No. 2	.073

This species betrays more of suilline character than any yet discovered in the Bridger series, but that it has any such affinity has yet to be shown. It was about as large as a fully-grown cow.

Bathmodon.

Some of the species of this genus possess powerful cylindric tusks of considerable length. The inferior tusks are sub-horizontal and prominent. In *metalophodon* the superior tusks are compressed and knife-like.

Phenacodus primaeous. Gen. et sp. nov.

Char. Gen., as expressed by a posterior superior molar tooth. Crown transverse, a little narrower and more strongly convex at the inner than the outer extremity. It supports five rather low and obtuse tubercles, two exterior and those on the inner side. Outer tubercles well inside the outer margin of the crown, the one sub-triangular in section, the other more nearly conical, the two connected by a low ridge which encloses a concavity with the outer margin of the crown. There inner tubercles arranged on the segment of a circle, sub-equal the lateral of one side, connected with the exterior tubercle of the opposite side by a low ridge, which encloses a basin with the inner tubercles.

Char. Specif. Median of the three inner tubercles stouter than the others. No noticeable basal cingulum. Two compressed roots with axes at right angles to each other, and very large pulp cavities, and thin walls.

Measurements	M.
Width of crown	0.0140
Length "	.0093
Elevation of outer cones above shoulder	.0050
Width between apices of outer cones	.0060
" " " median "	.0050

This tooth more nearly resembles the type of those of the lower quadrumana of the Bridger Eocene, but also more remotely of the suilline genus *Elotherium.* It would represent an animal as large as the orang. The only one of the genera named by Marsh, to which I can trace any likeness is his *Thinotherium,* described from inferior molars.

This name is pre-occupied ; see *Thinotherium annulatum*, Cope (Proceed. Am. Philos. Soc. 1870–1).

Locality.—Found by myself in the *Bathmodon* bone bed, near Evanston, Wyoming.

OROTHERIUM INDEX. Sp. nov.

Represented by both mandibular ramus with many of the molars in good preservation. These number P. M. 3, M. 3. The last premolar is somewhat like the first molar, but has but one posterior tubercle, and adds a cingular projection in front of the anterior pair. The first premolar has two roots ; the second is compressed, and with a broad heel behind. In the molars the anterior tubercles are connected by a cross ridge ; the posterior are a little more distinct from each other. The inner anterior tubercle is obtuse but not bifid, and its base is connected with the apex of the posterior outer by a diagonal ridge. There is a small median posterior tubercle on the No. 2, and a large heel on the last molar. It supports a conic tubercle, which is connected by sharp ridges with the tubercles preceding it. There is a cingulum on the outer face of the true molars, which does not extend on the base of the tubercle of the posterior pair.

Measurements.	M.
Length of molar series	0.0350
" " first premolar	.0032
" " third "	.0055
Width " " "	.0040
Length " second molar	.0065
Width " " "	.0045
Length " last "	.0098
Depth of ramus at first premolar	.0021
" " " second molar	.0023

NOTE. In determining the vertebrata of the Bridger Eocene, I have had recourse to the papers published by Prof. Marsh on this subject. It is well known his descriptions are short, yet, for the species, they are frequently sufficient. The case is otherwise with the genera, of which at least forty are named, very few of which are defined or characterized. In thirty, no mention is made of the numbers of either the premolar or molar teeth. In these manifold omissions we may discover not only the wisdom of silence, but also the silence of wisdom. It is to be hoped that Prof. Marsh will soon place his important results within reach of students, and allow his names to take a place in nomenclature, by an early publication of explanatory diagnoses.

October 25th, 1873.

Extracted from the Proceedings of the Academy of Natural Sciences, April, 1876.]

On a Gigantic Bird from the Eocene of New Mexico.—Prof. Cope exhibited a tarsometatarsus of a bird, discovered by himself during the explorations in New Mexico, conducted by Lieut. G. M. Wheeler, U. S. A. The characters of its proximal extremity resemble in many points those of the order *Cursores* (represented by the *Struthionidæ* and *Dinornis*), while those of the distal end are, in the middle and inner trochleæ, like those of the *Gastornis* of the Paris Basin. Its size indicates a species with feet twice the bulk of those of the ostrich. The discovery introduces this group of birds to the known faunæ of North America recent and extinct, and demonstrates that this continent has not been destitute of the gigantic forms of birds, heretofore chiefly found in the Southern Hemisphere faunæ. The description is as follows:—

The hypotarsus is moderately prominent, with broad truncate face, and does not inclose the ligamentous groove of its inner side. Its superior angle is broken away in the specimen. The two foramina which pierce the shaft just below the head, are well separated from each other both on the posterior and anterior faces, marking nearly equal thirds of the transverse diameter of the bone. The cotyloid cavities for the tibio-tarsus are bounded by an elevated margin, and are separated medially by a single low oblique ridge. The groove of the posterior face is particularly wide, and the inner part of the shaft is thinned, while the outer border is broadly convex. The proximal part of the inner border (as far as it is preserved) is marked with a flat surface which is roughened with ridges, which is perhaps the sutural articulation of the proximal end of the metatarsus of the hallux. No such surface exists on the corresponding bone of the ostrich or emeu. Only two of the free distal phalangeal extremities are preserved. The shaft is broken, showing that its interior is filled with cancellous tissue. The free extremities are remarkable for the great inferior extent of the articular trochlear face. The median is strongly grooved with an obtuse excavation, and the lateral or bordering ridges are equal and rounded. The groove is continuous with the superior surface, but not with the inferior. There the convergent lateral ridges inlosing the open groove, terminate in an abrupt elevation above the adjacent surface of the shaft. The sides at this point are concave. The inner free condyle has an oblique articular face, the external ridge dropping away internally as in many birds, and produced beyond the inner ridge, distally. The articular face becomes then a part of a spiral, and is little grooved above, but strongly grooved

medially. The vertical diameters of the sides differ, the inner being much greater, and both are concave. A strong foramen pierces the shaft just within the point of junction of the inner and medial free extremities.

Measurements.		M.
Transverse diameter of proximal end of tarsometatarsus		.100
Antero-posterior do. (partly inferential)		.070
Interval between penetrating foramina on anterior face shaft		.017
Median distal condyle	Long diameter	.050
	Vertical diameter	.048
	Transverse diameter	.040
Internal distal condyle	Long diameter	.037
	Vertical diameter	.040
	Transverse diameter	.031

The large size and wide separation of the penetrating foramina, and the thin internal edge with sutural articular facet, distinguish this form as distinct from any of the genera of Struthionidæ and Dinornithidæ. It is therefore named *Diatryma gigantea.*

On the Theory of Evolution.—Prof. Cope gave a history of the progress of the doctrine of evolution of animal and vegetable types. While Darwin has been its prominent advocate within the last few years, it was first presented to the scientific world, in a rational form, by Lamarck of Paris, at the commencement of the present century. Owing to the adverse influence of Cuvier, the doctrine remained dormant for half a century, and Darwin resuscitated it, making important additions at the same time. Thus Lamarck found the variations of species to be the primary evidence of evolution by descent. Darwin enunciated the law of "natural selection" as a result of the struggle for existence, in accordance with which "the fittest" only survive. This law, now generally accepted, is Darwin's principal contribution to the doctrine. It, however, has a secondary position in relation to the *origin* of variation, which Lamarck saw, but did not account for, and which Darwin has to assume in order to have materials from which a "natural selection" can be made.

The relations exhibited by fully grown animals and plants with transitional or embryonic stages of other animals and plants, had attracted the attention of anatomists at the time of Lamarck. Some naturalists deduced from this now universally observed phenomenon, that the lower types of animals were merely repressed conditions of the higher, or in other words, were embryonic stages become permanent. But the resemblances do not usually extend to the entire organism, and the parallels are so incomplete, that this view of the matter was clearly defective, and did not constitute an explanation. Some embryologists, as Lereboullet and Agassiz, asserted that no argument for a doctrine of descent could be drawn from such facts.

The speaker, not adopting either view, made a full investigation into the later embryonic stages, chiefly of the skeleton of the Batrachia, in 1865, and Prof. Hyatt, of Salem, Mass., at the same time made similar studies in the development of the Ammonites and Nautili. The results as bearing on the doctrine of evolution were published in 1869 (in "The Origin of Genera"). It was there pointed out, that the most nearly related forms of animals do present a relation of repression and advance, or of permanent embryonic and adult type, leaving no doubt that the one is descended from the other. This relation was termed *exact parallelism.* It was also shown, that, if the embryonic form were the parent, the advanced descendant was produced by an increased rate of growth, which phenomenon was called *acceleration;* but that if the embryonic type were the offspring, then its failure to attain to the condition of the parent is due to the supervention of a slower rate of growth; to this phenomenon the term *retardation* was applied. It was then shown that the *inexact parallelism* was the result of *unequal* acceleration or retardation; that is, acceleration affecting one organ or part more than another, thus disturbing the combination of characters, which is necessary for the state of *exact parallelism* between the perfect stage of one animal, and the transitional state of another. Moreover, acceleration implies constant addition to the parts of an animal, while retardation implies continual subtraction from its characters, or atrophy. He had also shown (Method of Creation, 1871), that the additions either appeared as *exact repetitions* of preëxistent parts, or as *modified repetitions*, the former resulting in simple, the latter in more complex organisms.

Professor Haeckel, of Jena, has added the keystone to the doctrine of evolution in his gastræa theory. Prior to this generalization, it had been impossible to determine the true relation existing between the four types of embryonic growth, or, to speak otherwise, than that they are inherently distinct from each other. But Haeckel has happily determined the existence of identical stages of growth (or segmentation) in all of the types of eggs, the last of which is the *gastrula;* and beyond which the identity ceases. Not that the four types of gastrula are without difference, but this difference may be accounted for, on plain principles. In 1874, Haeckel, in his Anthropogenie, recognizes the importance of the irregularity of time of appearance of the different characters of animals, during the period of growth, as affecting their permanent structure. While maintaining the view that the low forms represent the transitional stages of the higher, he proceeds to account for the want of exact correspondence exhibited by them at the present time, by reference to this principle. He believes that the relation of parent and descendant has been concealed and changed by subsequent modifications of the order of appearance of characters in growth. To the original, simple descent he applies the

term *palingenesis;* to the modified and later growth, *cœnogenesis.* The causes of the change from palingenesis to cœnogenesis, he regards as three, viz.: acceleration, retardation, and heterotopy.

It is clear that the two types of growth distinguished by Prof. Haeckel are those which had been pointed out by Prof. Cope in "The Origin of Genera," as producing the relations of "exact" and "inexact parallelism;" and that his explanation of the origin of the latter relation by acceleration or retardation is the same as that of the latter essay. The importance which he attaches to the subject was a source of gratification to the speaker, as it was a similar impression that led to the publication of "The Origin of Genera" in 1869.

It remains to observe that the phenomena of exact parallelism or palingenesis, are quite as necessarily accounted for on the principle of acceleration or retardation, as are those of inexact parallelism or cœnogenesis. Were all parts of the organism accelerated or retarded at a like rate, the relation of exact parallelism would never be disturbed; while the inexactitude of the parallelism will depend on the number of variations in the rate of growth of different organs of the individual, with additions introduced from time to time. Hence it may be laid down, that *synchronous acceleration* or *retardation* produces exact parallelism, and *heterochronous acceleration* or *retardation*, produces inexact parallelism.

In conclusion, it may be added that acceleration of the segmentation, the protoplasma or animal portion of the primordial egg, or retardation of segmentation of the deutoplasma or vegetative half of the egg, or both, or the same relation between the growth of the circumference and centre of the egg, has given rise to the four types which the segmentation now presents.

An analysis of the laws of evolution may be tabulated as follows:—

		Exact parallelism, the product of *Palingenesis,* which is *synchronous*....	*Inexact parallelism,* the product of *Cœnogenesis,* which is *heterochronous*....
acceleration, which proceeds by	Exact repetition..............	*	*
	Modified repetition	*	*
	Heterotopy	*	*
retardation, which proceeds by	Exact atrophy	*	*
	Inexact atrophy (or senility)[1]..	*	*

[1] So called by Professor Hyatt.

On the Tæniodonta, a new group of Eocene Mammalia.—Prof. Cope described the characters of some mammalia from the Eocene of New Mexico, obtained by him during the Wheeler expedition of 1874, which he regarded as allied to the *Insectivora*. The feet are armed with compressed claws. The dental characters are seen first in the supposed superior incisors. Unfortunately, they have not yet been found in place in the cranium, but their association with a rodent type of inferior incisors, which have been found in place in the mandible, confines us to the alternative choice between superior incisors and canines. From the small size, or absence, of inferior canines, a similar character may be inferred for the superior canines.

These superior incisors present two bands of enamel, an anterior and a posterior. They are compressed in form, the sides presenting a surface of dentine or cementum. Attrition produces a truncate or slightly concave extremity. The inferior incisors are rodent-like.

Two families represented this suborder in the Eocene period in New Mexico. The first, or *Ectoganidæ*, possesses molar teeth with several roots; in the *Calamodontidæ*, each molar has a simple conic fang. But one genus of each family is known. In both the enamel of the molars is principally a band on the outer side of the crown; the deficiency is supplied in *Calamodon* by a deposit of cementum, which invests the molar and superior incisor teeth, covering the crowns, excepting where the enamel bands are present. The latter investment is so much thinner, that the cementum forms a raised border all round at the point of junction of the two substances. The general structure of *Calamodon* affords some points of approximation to the *Edentata*, which indicate that the *Tæniodonta* partially fill the interval between that order and the *Insectivora*, presented by the existing fauna.

Prof. Cope also pointed out the close resemblance between the mandibular dentition of the cotemporary Eocene genus *Esthonyx*, and the existing *Erinaceus*, and stated that that of *Anchippodus* and allies chiefly differs from the latter in the persistent growth of the incisor teeth.

PHILADELPHIA, April 18, 1876.

ABSTRACT OF REMARKS MADE BEFORE A MEETING OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, JUNE 8th and 15th, 1875.

On some new fossil Ungulata.—Prof. Cope exhibited specimens of the following ungulates, found by himself in New Mexico.

Pliauchenia humphreysiana, Cope, gen. et sp. nov.

Char. gen. Represented in the collection of the expedition by a left mandibular ramus which includes alveolæ of all the teeth, and greater or less portions of all the molars except the last, and the first premolar. In the specimen the dental formula is I. ? C. 1; P. m. 3; M. 4; or one premolar less than in *Procamelus*, and two more than in *Auchenia*. On this ground the present animal is regarded as representing a new genus of *Camelidæ*, intermediate between the genera named. A portion of the left maxillary bone of a larger species is thought to belong to the same genus, although it presents the number of premolars found in *Procamelus*, viz., four. The first and second are, however, very close together, so as to leave about the same relative interval between the first and third as is seen in the *P. humphreysiana*, should the second premolar be omitted. The latter tooth is wanting from the lower jaw of the *P. humphreysiana*. The difference in dental formula between the superior and inferior dental series admitted provisionally in *Pliauchenia*, finds justification in the formula of the llamas (*Auchenia*), where the premolars are $\frac{2}{1}$.

Char. specif. The animal now described is of about the size of the *Procamelus occidentalis*, or somewhat larger than any of the existing llamas. The mandible is stout and deep, contracting rapidly forwards. The canine and first premolar are especially stout, and separated by a very short diastema; that separating the first and third premolars is also short, being less than that which separates the first and second in *Procamelus occidentalis;* could it be supposed that the second premolar is abnormally absent from the *P. humphreysiana*, the diastema would be reduced to a very small compass. Without this supposition the diastemata, both before and behind the first premolar, are shorter than in any of the *Procameli*, as *P. robustus*, *P. angustidens*, *P. heterodontus*, and *P. gracilis*. The mental foramen issues below the anterior border of the first or caniniform premolar, and the anterior border of the latter marks the posterior margin of the symphyseal suture. The third premolar is nearly as long as, but narrower than the fourth, and the true molars increase rapidly in size posteriorly.

Measurements.	M.
Length of dental series from front of canine to front of last molar	.125
Length from canine to P. m. No. 1	.010
Long diameter of first premolar	.010
Diastema to third premolar	.023
Length of third premolar	.011
" " first true molar	.019
Width of crown of first true molar	.011
Length of crown of second true molar	.025

This species is dedicated to General A. A. Humphreys, Chief of the Topographical Engineers, in recognition of the enlightened interest in all departments of scientific investigation, exhibited in his long and able administration.

PLIAUCHENIA VULCANORUM, Cope, sp. nov.

Represented by the left maxillary bone of a camel of about the size of the existing dromedary, and considerably larger than the species last described. The dental formula is, molars 4—3. The first premolar is only removed from the second by a diastema equal to the long diameter of the latter. The latter has no inner cingulum, while in the third it is so strong as to constitute an internal crescent. The third is much larger, and exhibits the usual single external and single internal crescents. The first molar is stout, long rooted, and furnished with a strong ridge on the outer side, bounding the posterior crescent-bearing column in front. There is a weak ridge on the middle of the anterior column, and only a rudiment on the last premolar. There are no cingula on either the inner or outer bases of the crown. The enamel is nearly smooth. A palato-maxillay foramen issues opposite the anterior border of the base of the third premolar.

Measurements.	M.
Length from posterior border of first premolar to posterior border of first molar	.090
Length of first true molar	.030
Width of bases of crown of first true molar	.024
Length of fourth premolar	.019
Width of base of crown of fourth premolar	.018
" " palate of first true molar	.040

The typical specimen was found near Pojuaque, a village of the Pueblo Indians. Various bones of camels of the size of the *P. vulcanorum* were also found, some of which doubtless belong to it.

HIPPOTHERIUM CALAMARIUM, Cope, sp. nov.

This three-toed horse is indicated by the oral and palatine parts of the skull with the superior dental series of both sides, together with one mandibular ramus with all its teeth, of an individual from near San Ildefonso, and also probably by molar teeth of two individuals from the Loup Fork beds of Colorado. The species is allied to the H. *paniense*, Cope, and differs from

the *H. occidentale*, *H. speciosum*, and *H. gratum* of Leidy, in the relative form and size of the interior dentinal column. In the two species first named, this column is subcylindric and equal to or smaller than the posterior internal columnar fold; in the three species last named the anterior column is flattened or oval in section, and often larger than the posterior columnar fold, and submedian in position.

In the typical or New Mexican specimen the anterior column is large, and its centre is anterior to the middle transverse line of the crown. In the present state of attrition, which has left two-thirds of the crowns of the median molars, this column presents an angular projection towards the inner anterior crescent, betraying an approach to the union seen in *Protohippus*, which is in the fifth molar of the right side of the present horse, actually accomplished through the medium of a narrow isthmus. The dentinal band, connecting the inner crescents, throws out two, rarely one, fold towards this column. The borders of the lakes are much plicate, the posterior border of the anterior lake having from four to six inflections. The posterior border of the posterior lake exhibits one deep inflection, which is generally bifurcate.

The first premolar is quite small, and is two-rooted; the second is a wide tooth, different in form from the elongate corresponding tooth of the *H. occidentale*, its anterior lobe being but little prominent. The palate is wide and well arched. The mandibular teeth are elongate, but not narrow, and the interior lobes are well developed, especially the median ones. No basal cingula on teeth of either jaw. The last molar is smaller than the three preceding it, and the anterior lobe of the first is quite narrow.

The molars of one of the specimens from Colorado are closely similar in all respects, except that the anterior lobe of the second premolar is a little more produced. I also refer here the tooth described as "No. 2," under *H. paniense*, in Report U. S. Geol. Survey, Terrs. 1873, p. 522–3. As compared with the molars of that species those of *H. calamarium* differ in the much greater complexity of the enamel folds, those of the *H. paniense* being the simplest in the genus, even more so than in *H. affine*. The anterior inner column of *H. paniense* lacks the characteristic inner angle seen in the present horse.

Measurements.	M.
Length of seven superior molars	.134
" " three true molars	.062
" " second premolar	.026
Width of crown of second premolar	.020
Greatest length of second premolar	.022
" width " " "	.024
" length " penultimate molars	.022
" width " " "	.022
Width of palate (chord) between middle of third premolars	.042
Length crown antepenultimate lower molar	.021
Width " " " "	.012

The typical specimen belongs to an adult animal, and was taken from the matrix by myself without admixture of others.

APHELOPS JEMEZANUS, Cope, sp. nov.

That a second species of rhinoceros, even larger than the other species of *Aphelops*, formerly existed in the region of New Mexico, is demonstrated by a right mandibular ramus obtained by Dr. H. C. Yarrow, from near the town of Santa Clara, on the west side of the Rio Grande. The specimen in its present condition includes the condyle, angle, and ramus as far as the last premolar, and supports the three true molars. The latter are worn, indicating the full age of the animal. They still retain the enamel surface of the sinus between the posterior and median transverse crests, and the lower end of the sharp inner margin of the anterior transverse crest.

While the ramus exhibits the compressed form seen in *A. megalodus* and *A. meridianus*, it differs from these and the *A. crassus* in many striking respects. Thus the inferior margin near the angle does not exhibit the protuberance and following contradiction of the inner side seen in the first two species. In another feature it differs from all the other species, *i. e.*, in the form of the ascending ramus. This rises very gradually from the basis of the last molar, leaving a subhorizontal edentulous space behind the latter as long as the second true molar. Its anterior face, instead of being flat and bounded by strong, lateral, angular ridges, as is the case in *A. crassus* and the two other species, is rather narrowly convex. Instead of the usual ridge of the outer side, the anterior border of the area of insertion of the masseter muscle is marked by a permanent curved protuberant margin, which is wanting in the three other species, the surface in them being plane. Behind the condyle is seen the tuberosity characteristic of the Rhinoceridæ. The internal pterygoid fossa is well marked. Rugosities for insertion of the lower border of the masseter muscle are strong.

The relations of the dentition of this species are also peculiar. The last molar is nearly half as large again as that of specimens of *A. megalodus*, and *A. meridianus* of similar dimensions of ramus, and the teeth diminish in length anteriorly more rapidly than in width. Thus, while the first true molar is as long as in the two species named, the width is between one-half and one-third greater. There are no external basal cingula.

Measurements.	M.
Length of ramus from fourth premolar (behind) to middle of masseteric fossa	.240
Length of series of true molars	.148
" " first true molar	.044
Width " " " "	.033
Length " third " "	.058
Width " " " "	.035
Diameter of ramus at first molar	.080
Depth of ramus of third "	.092

The Geology of New Mexico.—Prof. Cope stated that the ground covered by the geological investigation conducted mainly in New Mexico during 1874 in connection with the Wheeler U. S. topographical and geological survey, embraces the eastern slope of the Rocky Mountains from Pueblo to the Sangre de Christo Pass; both sides of the Rio Grande Valley from that point to Algodones, N. M.; the western or Sierra Madre range, and the country for forty miles to the westward of it, from the latitude of Sierra Amarilla as far south as the road from Santa Fé to Fort Wingate.

Little of novelty has been added from the first two named regions, as they have been previously traversed by competent geologists; but the last named has remained up to the present time almost unknown. The analysis of the structure of the Sierra Madre range is believed to indicate that its elevation took place near the close of the period known as Cretaceous No. 4, and that the elevating force was in New Mexico, more powerful at its southern extremity than along the middle portions of its line. Another important discovery is the lacustrine character of the triassic beds which form a part of the axis of the range; indicating the existence of extensive areas of dry land at that period, of which no portion is remaining in the region examined by me, but which may be supposed to be represented by the palæozoic beds further south and west. A third important point is the determination that the plateau drained by the eastern tributaries of the San Juan River it composed of the sediment of an extensive lake of Eocene age, which was probably at one time of great extent, but whose deposits have been greatly reduced in extent through erosion. The boundaries of this lake to the east and south were determined.

It is believed that additional light has been thrown on the question of the age of the Galisteo sandstone; and that its paleontology has decided definitely that of the Santa Fé marls. The first fossils discovered in the "trias" of the Rocky Mountains, have enabled me to reach more definite conclusions as to its position in the scale of periods.

The remains of vertebrata obtained from the latter formation are those of fishes and reptiles. The former are rhomboganoid scales of small species which are numerous in the coprolites of the reptiles; the latter represent the three orders of *Crocodiles*, *Dinosauria*, and apparently of *Sauropterygia*. The dinosaurian order is represented by a part of the crown of a tooth of a species of large size, of the general character of *Laelaps*. Both faces are convex, the one more so than the other, and the long axis of the crown is curved towards the less convex side. Both cutting edges are sharply and closely crenate denticulate as in *Laelaps*, *Aublysodon*, etc.; otherwise the enamel is perfectly smooth. There was not enough of this animal discovered to enable me to identify it. The suspected sauropterygian species is represented by a single vertebra with the centrum slightly depressed, circular section,

and about as long as wide. The neurapophysis appears to have been united by suture, although this point is not so clear as desirable, and the bases of the diapophysis are very stout, extending the entire length of the upper half of the lateral surface of the centrum. Of the articular faces, one is much more concave than the other. Length of centrum, m. .05; width, .057; depth, .055. The crocodilian remains consist of a portion of a jaw bone with alveoli for four teeth, of a broken vertebra, and a number of dermal-scuta and fragments of other bones. At another locality not far distant, were found numerous remains of saurian bones, embracing dermal and cranial pieces, coprolites, a fragmentary tooth, etc., which may have some affinity to these. The species indicated by the former may be named and described as follows:—

Typothorax coccinarum, Cope, genus et species nova.

Character genericus. The fragment of jaw belonging to this genus is probably maxillary in position, for the following reasons: the interior face of the bone is sutural, and for the most part solid. This would refer it to the position of the symphyseal portion of the dentary bone of a gavial-like form, but for other considerations. Supposing the piece to be dentary, and the suture therefore vertical, the incongruity follows that the alveolar face becomes very steep, so much so as to prevent the interlocking of the teeth, which become lateral in position. If, however, the jaw fragment be reversed in position, and the alveolar face placed in a horizontal position, the suture of the inner side forms a sharp angle with the vertical plane, as it should on the supposition of its being the maxillary bone. The wedged-shaped section necessary to fill the space between it and the median plane, will then be that of the prolonged posterior spine of the premaxillary bone. The solidity of this portion of the muzzle is inconsistent with the gavial genera of the Jura and later times, but not with the structure of the triassic Belodons. The posterior part of the inner face is, however, strongly excavated, and the sutural margin exhibits an outward deflection, which is either the boundary of the nostril, or the suture for the apex of the prefrontal or nasal bone. In either case the nasal cavity and the nostril are posterior in position in conformity with the structure of the "thecodont" crocodilia. The alveoli are large and arranged in a curved line, one of them somewhat exterior in position and isolated by a short diastema like a canine. Surface of the bone pitted. The dermal scuta found close to the jaw fragment have a flat upper surface marked with shallow pits rather closely placed, having resemblance to an obsolete Trionyx sculpture. Near one of the margins of the bone, the pits run out in shallow grooves. A portion of a vertebral centrum found with the jaw exhibits one articular face; this is shallow, concave, of the type of the Amphicoelian division of *crocodilia*. The body of the centrum is much compressed.

The other remains include a portion of a dermal bone like those described, and the crown of a tooth among other fragments. This crown, which has lost most of its enamel, is triangular in section, and somewhat curved in its long axis. A convex face is directed forwards and outward (on the supposition that the tooth is superior), and a nearly plane face posteriorly. The inner face is worn flat by the attrition of an opposing tooth. The pulp-cavity is minute or wanting.

Char. specif. The pitting of the maxillary bone is not linear, and is sometimes round; it is rather remote. The outside of the bone is steep, indicating that the muzzle is not depressed. Its face is swollen opposite the supposed canine tooth. The alveolæ are round, and longitudinally oval. The alveolar face is decurved near the end of the muzzle. The superficial layer of the cranial and dermal bones is dense and fine grained. The second series of specimens, whose reference is by no means certain, but which contains a dermal bone like that of the type, includes fragments apparently of the upper surface of the cranium. This is marked with irregular tuberosities and excavations resembling that seen in the Belodonts of the Carolinian and Würtembergian Trias. A section of a narrow dermal bone displays an elevated obtuse median keel, the only bone which displays this form in the collection, the usual form being either flat or slightly concave. Accompanying the same, are numerous coprolites, which are apparently too small for an animal of the dimensions of the type specimen. They are slender, and display rectal folds, which do not exhibit a continuous spiral. They are found, wherever fractured, to be filled with the rhomboganoid scales of some small fish.

Measurements.		M.
Length of fragment of maxillary		.095
Depth (oblique) at ? nostril		.050
Depth (vertical) "		.045
Width (median) "		.025
Width at front alveolus		.035
Diameter canine alveolus		.015
Diameter of another alveolus		.011
Diameter centrum (? caudal) vertebra	transverse	.024
	vertical	.022
Thickness of dermal shield		.008
Measurement across four fossæ of do.		.020
Diameter of crown of tooth No. 2		.018
Length of coprolite of No. 2		.045
Diameter " "		.011

The flat and regularly pitted dermal bones distinguish this genus from *Belodon*. The species was of large size, the cranial fragments equalling corresponding portions of the Gangetic gavial.

The evidence derived from the *Typothorax coccinarum* is favorable to the identification of this horizon with that of the Trias, although it cannot of course be regarded as conclusive, until more perfect specimens are obtained.

Besides the overlying sandstone bed, the red marls are traversed below it by a conglomerate, which is in some places of a bluish tint. At some points it weathers to gravel, and near this horizon the vertebrate remains occur.

In review I give the following section of the Eocene rocks of the region west of the Sierra Madre range:—

Red and gray marls	Wahsatch Group	1500
Sandstone		1000
Green and black marls—Puerco group		500
		3000

The following is an approximate estimate of the mesozoic beds in the same region; as they were not accurately measured, the numbers will have to undergo revision; their relative thickness is nearly as given:—

Uncertain (concealed in the sage plain	500
Cretaceous No. 4	1500
Cretaceous No. 3	400
Cretaceous No. 2	2000
Cretaceous No. 1	500
Jurassic	600
"Trias" (bottom not seen)	1000
Total	6500

The mesozoic beds of this section (excepting some of the higher members of the cretaceous) have been examined over extensive areas to the west and south, by Messrs. Marcou and Newberry, whose valuable reports accompany those of Lieutenants Whipple and Ives, on the routes surveyed by them through Arizona and New Mexico. The horizon here termed, after Hayden, "Triassic," has been referred to this formation by Marcou also, who had the opportunity of examining it in Texas and the Indian Territory. So far as the latter region is concerned, I can confirm the identification, having examined bones from the in beds of that country, which appear to be those of Belodonts. Dr. Newberry terms it, in Arizona, the "salt group," or "saliferous sandstones," referring to it as probably including both Triassic and Permian strata.

The formations here called jurassic are partially included by Marcou in his triassic series; and are termed the "variegated marls" by Dr. Newberry, who is inclined to refer them to the jurassic.

June 28, 1875.

No. 20

ON THE

SUPPOSED CARNIVORA OF THE EOCENE

OF THE

ROCKY MOUNTAINS.

BY

E. D. COPE.

Extracted from the Proceedings of the Academy of Natural Sciences, Nov. 30, 1875.]

PHILADELPHIA:
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1875.

On the supposed Carnivora of the Eocene of the Rocky Mountains.—Animals which fulfilled the functions of the existing *Carnivora* were abundant in North America during the Eocene period. The Wahsatch beds of New Mexico have yielded remains of more than a dozen species, which ranged from the size of a weasel to that of a jaguar. Investigation into the structure of these shows that while they differ in minor points among themselves, they agree in possessing characters which distinguish them from the true *Carnivora*. I have already pointed out,[1] that, in the genera *Amblоctonus*, *Oxyæna*, *Stypolophus*, and *Didymictis*, the tibio-tarsal articulation differs from that of the existing *Carnivora*, and suggested that these forms might prove to be gigantic *Insectivora*. Further investigation has satisfied me that they cannot be included in the order *Carnivora*, and their systematic position proves to be of considerable interest.

A greater or less part of the cranial chamber is preserved in specimens of *Oxyæna forcipata* and *Stypolophus hians*. In these animals it has a long, narrow form like that of the opossum, and in the first named, where the interior form can be seen, it is evident that the cerebral hemispheres were small and narrow, and that the olfactory lobes were relatively large, and were entirely uncovered, projecting beyond the hemispheres.

In *Amblоctonus*, *Didymictis*, and three undetermined forms, the femur supports a third trochanter. In all the genera the ilium has a well-marked external anterior ridge, which continues from the acetabulum to the crest, distinct from the internal anterior ridge. The ilium has, therefore, an angulate or convex external face, as in *Insectivora* and *Marsupialia*, and does not display the usual expansion in a single plane of most of the placentals. In all the genera there is a strong tuberosity in the position of the anterior inferior spine, which is wanting in the *Mammalia*, excepting certain *Insectivora* and *Prosimiæ*,[2] although it marks the position of the origin of the rectus femoris muscle in all types.

The glenoid cavity of the squamosal bone is transverse, and well defined anteriorly and posteriorly, as in the *Carnivora*. Of the first series of carpal bones of the four genera named, I have been able to learn nothing, but in the genus *Synoplotherium* from the Bridger Eocene of Wyoming, which probably belongs to this group, the scaphoid and lunar bones are separate and not united as in the *Carnivora*.

The above characters point to the *Marsupialia* or the *Insectivora* as the proper location for the flesh-eaters under consideration; and the evidence is much more weighty in favor of the latter order as their true position. For in the genera *Oxyæna* and *Didymictis* the posterior part of the inferior border of the mandibular ramus is not inflected as in *Marsupialia*, nor are the anterior inferior iliac tuberosity and third trochanter seen in that order, while both exist in the *Insectivora*.

Cuvier describes[3] the tibia of *Carnivora* as follows: "Quant à

[1] Systematic Catalogue of the Vertebrata of the Eocene of New Mexico, 1875, p. 7.

[2] See the figure of *Solenodon* by Peters, and *Chiromys* by Owen.

[3] Ossemens Fossiles, vii. p. 112.

la tête inférieure, tous les carnassiers se distinguént de l'homme par sa figure plus étroite du côte externe que le l'interne, et par sa division en deux fosses oblique, au moyen d'une arête arrondie qui repond à la partie de l'astragale. . . Le phoque l'a cependant d'une forme très-particulière par l'excessif aplatissement de sa moitié supérieure, et par sa facette particulaire inférieure, qui est en concàvité simple et peu profounde."

The astragalar articular face of the tibia in the genera above named is not divided into the two oblique fossæ by "a rounded crest which is applied to the groove of the superior pully-shaped face of the astragalus." It is uninterrupted and more or less oblique in the transverse direction; always so at the posterior border. The inner malleolar process is produced downwards, and rests in a concavity on the inner side of the neck of the astragalus. The astragalus, which I have seen in several of the species, presents a corresponding trochlear face. That is, instead of a groove, it presents an open angle upwards, which separates the superior from the oblique internal face. The superior plane is flat, but is interrupted on the posterior side by a groove. This groove is the posterior extremity of that which divides the superior face of the astragalus in the higher *Mammalia*, but here it contracts to a point and disappears next the fibular face just as it reaches the superior surface. The fibular face is vertical, and shares on its posterior part a large ligamentous fossa with the opposed part of the fibula. The distal end of the fibula is remarkably stout.

This structure finds its counterpart in the internal half of the astragalus of the opossum. The arrangement permits a rotary movement of the astragalus and thus of the whole foot, on the tibia, the fibula with its fixed articulation with the astragalus, rotating on the tibia, as in the pedimanous *Marsupialia*. The flatness of the inner malleolus in some of the species indicates that the capacity for rotation was less in them than in others. This arrangement exactly reverses the extensive oblique fibulo-astragalar articulation seen in the opossum, the *Petaurista*, *Dasyurus*, etc. Prof. Owen, in describing the astralagus of the wombat (*Phascolomys*), says: "The upper articular surface for the tibia is as usual concavo-convex, the internal surface for the inner malleolus flattened, and at right angles with the preceding, but the outer articular surface presents a triangular flattened form, and instead of being bent down parallel with the inner articular surface slopes away at a very open angle from the upper surface, receiving the articular surface of the fibula so as to sustain its vertical pressure. * * * This form of astragalus is also characteristic of the Koala, Petaurists, Dasyures, and the Pedimanous Marsupialia."

In one species where the cuboid bones are preserved, it is evident that the distal end of the astragalus articulated with this as well as with the navicular bone, although the facet of the astragalus is single and continuous. As the extensive transverse distal astragalar face is characteristic of all the species where it is preserved, the contact of the cuboid and astragalus is probably common to all of this division.

The dentition of this group is consistent with its reference to

the sarcophagous *Marsupialia* or to the *Insectivora*. It has, however, decided resemblances in the form of the molars, and in the deficiency in the number of the inferior incisors, to such genera of *Insectivora* as *Mythomys* and *Solenodon*, while in the large canines, it more nearly approaches *Sarcophaga* and *Carnivora*.

I propose to include the genera *Ambloctonus*, *Oxyæna*, *Stypolophus*, and *Didymictis* in a special division under the name of *Creodonta*. This division may be regarded as a suborder of the *Insectivora*. It is possible that the genus *Diacodon* Cope belongs here also; its species resemble *Chiroptera* in the inferior dentition, and are of small size. The genus *Mesonyx*,[1] which I discovered in the Bridger beds of Wyoming, cannot be referred to the *Creodonta* as here constituted, since the trochlear face of the astragalus is completely grooved above as in the true *Carnivora*, and its distal end presents two distinct facets, one for the cuboid and the other for the navicular bones. It represents on this account a peculiar family, the *Mesonychidæ*.

To the *Creodonta* must be referred the genera *Pterodon* and *Palæonictis* of De Blainville, from the French Eocene. This author and Pomel placed them in the *Marsupialia*, but Professor Gervais remarks (Geologie et Paleontologie Française) that the evidence is insufficient for such a course. Here also doubtless belong supposed *Carnivora* from the Wyoming Eocene, stated by Marsh to be allied to the *Viverridæ*.

The remarkable type first introduced to the notice of paleontologists by Leidy, represented by the genera *Anchippodus*, *Ectoganus*, etc., has been looked upon as an order of *Mammalia* by Marsh, and termed the *Tillodontia*. He gives,[2] as its characters, the possession of claws, plantigrade feet with five toes, a third trochanter of the femur, and separate scaphoid and lunar bones. Also, that the dentition is characterized by "molars of the ungulate type," small canines, and large scalpriform incisors in both jaws, faced with enamel and growing from persistent pulps as in the *Rodentia*. He says this order "seems to combine characters of the orders of carnivores, ungulates, and rodents."

Except in the dentition, the definition above given applies to the *Creodonta;* and an analysis of the dentition shows so many points of resemblance as to render it probable that they pertain to the same order of *Mammalia*. Also, except in the dentition, the characters given by Prof. Marsh do not differ from those of the *Insectivora*. The structure of the superior molars is not inconsistent with the same order, and the small canines and large incisors are even more like those of most *Insectivora* than are *Creodonta*. The singular form of these incisors, and their growth from persistent pulps, is rather characteristic of *Rodentia*. The transverse or tubercular premolars also distinguish this group from both the *Creodonta* and the true *Insectivora*. The definitions of the order and sub-orders will then be as follows:—

[1] Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 550.
[2] Amer. Journ. Sci. Arts, 1875, 231.

INSECTIVORA.—*Mammalia* with small cerebral hemispheres which do not cover the olfactory lobes, nor the cerebellum; with numerous clawed digits, and a third trochanter of the femur; with a transverse glenoid cavity for the mandible.

Superior incisors normal, not growing from persistent pulps; canines large; premolars compressed. Astragalus not grooved above, articulating with the cuboid as well as the navicular; five toes on the hind foot; *Creodonta.*

Superior incisors large, growing from persistent pulps, and without enamel on the sides; superior canines small when present; premolars wide or tubercular; *Tillodonta.*

These suborders of the order *Insectivora* do not differ among themselves more than do those of the *Marsupialia*, and constitute a series of parallels with them. Thus the *Creodonta* resemble the *Sarcophaga*, the *Insectivora vera* the *Entomophaga*, and the *Tillodonta* the *Rhizophaga*, typified by *Phascolomys.*

The genera of the *Creodonta* differ as follows:—

I. First and third inferior true molars without internal cusp. Last superior molar longitudinal; last inferior molar carnassial; *Amblyctonus.*

II. Inferior carnassials with interior tubercle; no tubercular molar; last superior molar transverse.

Three tubercular carnassials;[1] *Stypolophus.*

Two tubercular carnassials; *Oxyæna.*

III. Inferior carnassial with interior tubercle; a tubercular molar.

One tubercular carnassial; *Didymictis.*

The number of toes on the hind foot cannot be certainly stated in all the genera, but in *Stypolophus hians* and another species there were probably five, the inner being of reduced size. There is present in those species an ento-cuneiform bone which resembles that of *Canis;* it is compressed, with one truncate concave terminal facet, and an internal oblique one at the opposite and proximal extremity. The form of the truncate articular face of the distal end indicates the existence of an inner metatarsal bone of moderate proportions, which probably supported a small hallux. This thumb could not be opposable as in the opossum.

In general appearance the *Creodonta* differed from the *Carnivora*, in many of the species at least, in the small relative size of the limbs as compared with that of the head, and in some instances, as compared with the size of the hind feet. The feet were probably plantigrade, and the posterior ones capable of some degree of rotation. The probable large size of the rectus femoris muscle indicates unusual power of extension of the hind limb. They were furnished with a long and large tail. Probably some of the species resembled in proportions the *Mythomys* and *Solenodon*, now existing in Africa and the West Indies, but they mostly attained a much larger size. Published December 22, 1875.

[1] For the meaning of these expressions, see Syst. Cat. Eoc., New Mexico, 1875, p. 6.

PALEONTOLOGICAL BULLETIN,

No. 21.

(Read before the Academy of Natural Sciences, April 11, 1867.)

On the Geologic Age of the Vertebrate Faunæ of the Eocene of New Mexico.—Prof. COPE presented a synopsis of the species described from the Eocene of New Mexico, arranged in the following manner:—

MAMMALIA			54
Perissodactyla		10	
Amblypoda		9	
Pantodonta	9		
Incertæ sedis		3	
Quadrumana		10	
Prosimiæ	10		
Rodentia		3	
Insectivora		19	
Tæniodonta	4		
Bestiæ	2		
Creodonta	13		
AVES			1
REPTILIA			24
Crocodilia		7	
Testudinata		15	
Lacertilia		2	
PISCES			8
Ginglymodi		2	
Plagiostomi		6	

This total number of eighty-seven species may be considered in two aspects, viz., in regard to their geological position, and their anatomical structure.

As regards the former, it may be observed, that the record preserved in these beds is doubtless more imperfect than that found in many others, owing to various physical conditions. One of these is an evident disturbance of temperature and moisture which they have sustained, perhaps in connection with the volcanic phenomena which played so important a part in New Mexico during the later tertiary times. The fossils are generally found in a fragmentary condition, and often distorted by pressure. The fractures of the surface are often of such a kind as to indicate that the bones have been in a plastic state (see the figures of *Stypolophus hians*) during which the fissures thus created in them have in many instances been filled with a siliceous limestone. This material now presents a rough external surface of great hardness, and sometimes incrusts the teeth in such a way as to render it a difficult matter to expose them. Nodules of the same material abound on the bluffs (see the geological report). Not unfrequently the bones are covered with an incrustation highly charged with the red oxide of iron, and this substance gives its characteristic color to a large percentage of the fossils, the others being gene-

rally black or dark brown. The light colors of our miocene beds are almost unknown, and the bones are always much harder than these, or even than the fossils of the Bridger group of Wyoming. These facts, in connection with the reduced number of exposures of the beds, account for the comparatively small number of species obtained, and the feeble representation of certain groups, *e.g.*, the birds, lizards, rodents, etc. Nevertheless a large number of individuals were obtained, and a considerable extent of country explored, and I believe that the synopsis above given is an approximation to an expression of the characteristics of the most abundant types, or, of the relative numerical representation in the fauna of the different genera, orders, etc.

Comparison with the established scale of geological horizons of Europe has established the fact that the beds in question belong to the Eocene category, as I have already shown[1] to be true of the longer-known Bridger beds of Wyoming. It remains to collate them with the numerous subdivisions of that period. The differences between the Wahsatch and Bridger faunæ have been in part pointed out in my Report on the Vertebrate Fossils of New Mexico, 1874,[2] and may be more fully stated as follows:—

1. Divisions found in the Wahsatch beds not yet reported from the Bridger beds. Aves, genus *Diatryma* (allied to *Gastornis*); mammalia, *Tæniodonta; Phenacodus; Coryphodon;*[3] *Meniscotherium;* most species of *Hyracotherium.*

2. Divisions found in the Bridger beds not yet found in the Wahsatch: fishes, *Amiidæ;* reptiles, *Ophidia; Anostira;* mammals, *Mesonychiidæ; Tillodonta; Achænodon; Dinocerata; Palæosyops;* most species of *Hyrachyus.*

The Wahsatch horizon of Wyoming has not yielded so many species of vertebrata as those of New Mexico, but the close resemblance of the two faunæ may be observed in the following list of forms which I obtained at several localities: Fishes, *Siluroids;* mammals, *Hyracotherium*, two species; *Phenacodus; Coryphodon*, two to three species. As is well known the Wahsatch beds underlie those of the Bridger group, and we therefore look for their European equivalent in the lower part of the series. It has been already pointed out[5] that the absence of *Hyopotamus* and *Anoplotherium* and allied genera, from the Bridger horizon precludes an identification with the upper Eocene of Europe. The comparison of the Wahsatch fauna with that of the lowest of the three divisions into which Professor Gervais has arranged the European

[1] Proceedings American Philosophical Society, 1872, February and July.
[2] Annual Report of Chief of Engineers, p. 592.
[3] The species described by me as *Bathmodon* constitute a section of this genus, characterized by the absence of tubercle or ridge between the inner cusps of the last lower molar. I do not maintain this section as a distinct genus.
[4] See Report of the U. S. Geol. Surv. Terrs., 4to. ii. p. 33--39.
[5] Ann. Rept. U. S. Geol. Surv. Terrs., 1873 (1874).

Eocene, shows a remarkably close correspondence. This epoch, the Suessonien of D'Orbigny (Orthrocene Gervais), includes the marls of Rilly and lignites of Soissons, the Thanet sands, London clays, etc. Fossils from these beds appear to have been no better preserved than those of the Wahsatch beds of the Rocky Mountains, yet some of the genera are identical, and others closely correspondent, as follows:—

Wahsatch.	Suessonien.
Amblyctonus.	*Palæonyctis.*
Hyracotherium.	*Hyracotherium.*
Coryphodon.	*Coryphodon.*
Diatryma.	*Gastornis.*
Lepidosteus.	*Lepidosteus.*

As a point of difference between the beds, may be mentioned the absence of the *Tæniodonta* from the Suessonien, a suborder not yet known out of North America.

The Wahsatch formation includes the Geeen River beds of Hayden, a name which I formerly applied to the entire series. It, however, applies properly to the fish shales of Green River, containing *Asineops*, *Clupea*, *Osteoglossum*, etc., which are probably local in their character.

The Bridger formation will then represent on the American continent more nearly than any other, the middle Eocene or Parisien of Cuvier, Brogniart, and Renevier.

The teeth of sharks described in the reports quoted are of uncertain origin. They are associated with oyster shells, and both have the appearance of having been transported; nevertheless some of the mammalian teeth found associated with them have a similarly rolled appearance. It therefore remains uncertain whether the ocean had for a limited time access to the Eocene lake, or whether the shark's teeth and *Ostreæ* were derived from the cretaceous beds which formed its shores. Similar, and in one instance the same species of sharks were found in both formations, the division of the cretaceous being No. 3 and 4 of Hayden.[1]

In conclusion, the classification of the North American Eocene may be represented as follows:—

Formation.	Equivalent.	Locality.	Characteristic Fossils.
Bridger Form.	Middle Eocene.	S.W. Wyoming.	*Palæosyops.* *Tillodonta.* *Dinocerata.*
Wahsatch Form.	Lower Eocene.	N. E. New Mexico, S.W. Wyoming.	*Coryphodon.* *Tæniodonta.* *Phenacodus.* *Diatryma.*

[1] The same state of things exists in the siderolitic deposits of the canton of Vaud, Switzerland. Mingled with the mammalian remains are teeth of sharks, of which M. La Harpe remarks that their appearance does not warrant the belief that they have been transported, or are not indigenous to the Eocene fauna.

PUBLISHED APRIL 26, 1876.

14, p. 1

PALEONTOLOGICAL BULLETIN No. 22.

[Extracted from the Proceedings of the Academy of Natural Sciences of Philadelphia, October 31, 1876.]

DESCRIPTIONS OF SOME VERTEBRATE REMAINS FROM THE FORT UNION BEDS OF MONTANA.

BY E. D. COPE.

Aublysodon lateralis, sp. nov.

Established on some teeth, one of which is of the size of those of the *A. horridus*, and which differ in some important particulars. The posterior crenate ridge is as in that species, lateral in position, separating a posterior face from the lateral at a right angle. The posterior face is separated from that of the other side by a very obtuse angle. The anterior aspect of the crown is without crenate cutting edge, but the latter is present as a border to the front, passing along the front of the side opposite to that which bears the posterior angle. It is directed laterally, and projects beyond an open groove which follows its posterior base. The base of the crown is broad elliptic in section. Enamel smooth.

A much smaller tooth was found with the preceding, and presented similar characters, excepting that the posterior face is not so strongly truncate.

Measurements.		M.
Length of crown preserved		.025
Diameter of base of crown	long	.018
	short	.010
Width of posterior face		.006
Length of smaller crown		.011
Long diameter of base of do.		.006

The apices of both crowns are considerably worn by use. Both were found by Charles H. Sternberg of my exploring party.

Lælaps incrassatus, sp. nov.

Represented by two teeth, a larger and a smaller, which were found near each other, but not sufficiently so as to warrant the belief that they pertain to the same individual.

The characteristic feature of these teeth is, that the transverse diameter of the base of the crown exceeds its anteroposterior, a point in which it differs from all the other carnivorous dinosaurians yet known from the formation. Nevertheless, the posterior cutting edge is median, and is denticulated. The anterior cutting edge, which is also denticulated, is nearly median at the apex, but

continues along one side of the widening anterior face to the base of the crown. The posterior cutting edge is nearly straight, while the anterior is rather abrubtly curved at the apex.

The anterior and posterior edges are not lateral in position as in *Aublysodon lateralis.*

Measurements. M.

		No. 1.	No. 2.
Length of crown		.025	.014
Diameter at base	anteroposterior	.012	.006
	transverse	.0135	.008

A large species. Discovered by Jno. C. Isaac.

Lælaps explanatus, sp. nov.

An abundant species, but as yet represented only by teeth which are about the size of those of the largest of living *Varanidæ.*

The crowns are strongly compressed and curved; one side is flat, the other gently convex; the posterior cutting edge is median and concave. The anterior edge is not continued to the base of the crown, and disappears before attaining the apex; it is feebly denticulate, and only at its convex curvature towards the apex; its course is median. The flat face has a slight bevel to the posterior edge. Surface smooth, without transverse undulations.

Measurements. M.

Length of crown		.0110
Diameter crown at base	anteroposterior	.0066
	transverse	.0028

Lælaps falculus, sp. nov.

Represented by several teeth of about half the size of those of the last described reptile. They differ in form in several respects, being relatively shorter and stouter, and less sectorial in character. The lateral surfaces are about equally convex, while the anterior face is narrowly obtuse, and without cutting edge. The posterior edge is concave and furnished with a serration of smaller denticles than in the *L. explanatus;* it is median in position.

Measurements. M.

Length of crown		.0090
Diameter of base of crown	anteroposterior	.0056
	transverse	.0040

Found by Jno. C. Isaac.

Dysganus encaustus, Gen. et sp. nov.

Char. Gen.—A large number of teeth exhibit the characters of this genus, which is a peculiar form of herbivorous *Dinosauria.* The crowns are compressed, so that the fore and aft diameter much exceeds the transverse. The body of the crown is a flattened shaft of dentine, one face of which is the denser, and produces the cutting edge. This face is flat or weakly keeled, while there are two other faces uniting at an open angle, thus giving a subtriangular section. On each of these faces is adherent a shaft of cementum-like material of a dense character, whose external face is longitudinally concave. These inclose between them on the median line a deep groove, which expands below into a wide concavity, which appears to be enlarged as the age of the tooth increases preparatory to shedding. The other parts of the base of the crown below the cutting face, are inclosed in a rather thick deposit of rugose cementum, which rises a distance on the sides of the tooth.

The method of replacement of the teeth in this genus appears to resemble that of *Cionodon*, except that there is no indication of the existence of as many series in the transverse direction. The longitudinal grooves in the anterior and posterior cement columns are probably occupied by the borders of the apices of successional teeth. The presence of these columns, etc, distinguishes this genus from that and other allied genera.

Char. Specif.—The cutting face is more or less concave, and is impressed or sunken, its lateral borders, and the cement of the basis, projecting beyond it. The inferior border is also usually oblique, that of one of the sides rising diagonally. In the same proportion, a weak keel is also unsymmetrically placed, lying close to the opposite border, and dividing the face into a wide and a narrow concavity. The oblique border is also incurved, the edge of the posterior cement column curving round the cutting face of the dentine. The latter is delicately rugose in unworn specimens. The external basal cementum rises highest on the incurved border of the crown; its surface is minutely rugose, the rugosity being generally punctiform. It is also of a different color from the dentine in the specimens as preserved, and is occasionally found nearly worn away. The edge of unworn teeth is not serrate.

Measurements.		M.
Length of basis of tooth		.012
Diameter of crown	anteroposterior	.009
	transverse	.004
Transverse diameter below crown		.008

The teeth are rather smaller than those of *Hadrosaurus foulkei*, The borders present no indication of the crenation seen in that and other species, either in worn or unworn specimens.

Dysganus haydenianus, nov. sp.

Represented by a number of teeth found in such relation that they are supposed to belong to two individuals.

They differ materially in form from those of the *D. encaustus*, and exceed any of them in size.

The base of the tooth possesses the thick investment of rough cementum, and has a slope away from the base of the crown. The form of the crown is peculiar in possessing a lateral face placed at a strong angle to the usual face, and separated from it by a strong protuberant angular ridge. This angular cutting face would resemble that of the *Diclonii* were it not that the body of dentine of which it is composed is a flat plate instead of a triangular segment of a subquadrate prism. Each face has a separate plate, which is separated from the other by a suture. A solid mass fills the angle between them, which is divided by a groove produced by the pressure of the angle of the face of the succeeding tooth which fits it. The wider of the "front" faces is divided by a low longitudinal ridge. Both of the faces are bounded by an external incurved ridge which cause them to have a concave surface.

A tooth of a size equal to that of the one just described was found with it, has a form more nearly like that of *D. encaustus*, in the less degree of prominence of the lateral angle. It displays but a single posterior cementum-like mass, which presents considerable lateral faces as well as a posterior one, as in the first described tooth.

Measurements.		M.
Length of base of crown		.010
Elevation of remaining part of crown		.006
Diameter of crown	anteroposterior	.015
	transverse, total	.010
	" dentine	.004

Dedicated to Doctor F. V. Hayden, U. S. Geologist.

Dysganus bicarinatus, sp. nov.

This dinosaurian is represented in the collections by some of the teeth of three individuals. Two of the teeth represent immature stages, while the others are worn by continued use. They all present characters not found in the *D. encaustus*, from which they differ in a direction the opposite of that which characterizes the *D. haydenianus.*

The crowns present a nearly flat face without incurved lateral angles, nor prominent median keel. The basis is wide, projects in a rim beyond the face, and is invested with rough cementum. The face is peculiar in being divided into three planes by two low angular ridges, and its surface is smooth. The dentinal column is triangular, and there are two posterior columns separated by a fissure, in mature teeth.

The absence of the lateral incurved angle, and the presence of the two median ones distinguish this species from the *D. encaustus.*

Measurements.

		M.
Length of basis		.009
Width "		.011
Length of worn face		.006
Diameter of crown	anteroposterior	.011
	transverse	.007

Dysganus peiganus, sp. nov.

In the typical tooth of this species the form approaches the genus *Palæoscincus*, Leidy, in the compression of the crown, and the contraction of the base; it is a limital species of *Dysganus* if really properly placed in that genus.

The widest portion of the crown is above the base; from this expansion it contracts in both directions, and in the unworn tooth forms an angular median apex. This is not the case in *D. encaustus*, which is regularly rounded. The margin of the crown is narrowed, expanding but little towards the expansion, and is quite rugose. From these rugosities low ridges descend on the face of the tooth, whose surface is also minutely rugose. The face is divided by a prominent median rib, which extends to the apex. No cementum is visible on the basis, in the only specimen in which this part is preserved.

Measurements.

			M.
Length of crown			.008
Diameter of crown	transverse		.005
	anteroposterior	at base	.008
		greatest	.011

Diclonius pentagonus, Gen. et sp. nov.

Char. Gen.—Herbivorous dinosaurians, in which the teeth are elongate and without distinct root, and present dense material only on one side of the crown (the "front"), whose section produces a cutting edge. The other face of the tooth (the "back") is coated with cementum, and is absorbed during the protrusion of the successional tooth from below, which thus rises from "behind." In the anteroposterior direction the teeth are protruded alternately, and the lower parts of the crowns are contracted to give space for the apices of the adjacent young teeth. In the type of the genus there is but a single series of teeth.

In the known species of this genus, the dense face ("front") of the crown presents a longitudinal keel, but this is not necessarily a generic character. The terms "front" and "back" are not intended to be accurate, as the faces so termed are either external or internal, the direction being probably reversed in the two jaws.

This genus is allied to *Hadrosaurus* and *Cionodon.* From the former it differs in the mode of succession of the teeth, which, as determined by Prof. Leidy in that genus, is from the "front" of the base of the tooth, whereas, in *Diclonius*, the succession is as in *Cionodon*, from the "posterior" base of the tooth. This arrangement allows of a more continuous use of the dense face than in *Hadrosaurus*, where that face terminates as the young crown rises into functional position. A species from the Fort Union bad lands of the Judith River was described by Dr. Leidy as *Trachodon mirabilis.* Specimens of this species from the locality furnishing those of *Diclonius*, present the mode of succession ascribed by that author to *Hadrosaurus*, to which genus he afterwards referred the species under the name of *H. mirabilis.*

The dentition of species of this genus shows that but one tooth in mature functional use existed in a line transverse to the axis of the jaw at one time, and that alternating with these, one partially protruded crown, and one stump of a crown, present masticating surfaces in transverse relation. The formula for this genus should then be written 2—1, while in *Cionodon* it is 3—3—2.

The type of this genus exhibits a mode of nutrition of the young teeth similar to that seen in the genus *Saurocephalus* among fishes. The bone is perforated by a series of foramina, each of which conveyed an artery directly into the base of the growing crown.

Char. specif.—The front of the crown is divided longitudinally by a prominent median keel and the borders are not serrate. The keel is only moderately prominent at the lower part of the crown. The back of the crown is divided into three faces by two straight longitudinal parallel solid angles, and the crown is contracted near the base by the lateral bevels for the adjacent growing teeth. All these faces are covered by cementum, whose roughness is granular in character. The external surface of the jaw-bone has precisely the same character, so that the apices of the teeth only appear as prominences of its border.

The typical specimen is that of an individual of moderate dimensions; measurements of a tooth of a gigantic individual are given below.

Measurements.		M.
Length of a series of five teeth		.023
Protrusion of crown of largest tooth		.006
Diameter " " "		.006
Length of crown above lateral apical facets of larger animal		.013
Diameter of crown at same point	antero-posterior	.011
	transverse	.009
Width of median face of "back"		.005

Diclonius perangulatus, sp. nov.

This abundant species of herbivorous dinosaur has left its shed teeth in many localities of the Fort Union horizon, in company with those of the *Trachodon mirabilis*, *Palæoscincus costatus*, and other large reptiles. Teeth with complete apices are rare. The marked character of the species is seen in the prominence of the median angular ridge which divides equally the cutting face of the crown from apex to base. The prominence increases downwards so that the transverse diameter becomes greater than the antero-posterior, in some cases being diamond-shaped in the transverse direction. Its position is symmetrical, or nearly so. The lateral borders are smooth, one specimen displaying a faint trace of crenation near the apex. There is no shank or root in any of the teeth preserved, and the basis is excavated on the side away from the cutting edge for the apex of the successional tooth. A band of roughened cementum extends round the base, and is continued upwards on each side opposite the cutting face. This side presents three faces, a narrow median, and two wider lateral. The latter are slightly concave, and are probably adapted to the apices

of the successional teeth; the former is often slightly concave, and is the seat of most rapid attrition. The lateral facets disappear at a distance below the apex, where the non-cutting side is strongly convex, and covered with a coarsely rugose cementum; the rugosity including pits.

Measurements.		M.
Length of a shed tooth		.011
Diameter of crown	antero-posterior	.010
	transverse	.012
Width of facet for successional crown		.006
Width of posterior facet		.005
Width of cutting face of another near apex		.008
Antero-posterior diameter of do. at do.		.010

The prominence of the median angle with other points distinguishes this species from the *Cionodon arctatus*. The size is larger than that of the known specimens of that species, equaling that of the largest of the order. (See Report of U. S. Geological Surv. Terrs. II., 4to, for description of genus *Cionodon*.)

Specimens of this species have been referred by Dr. Leidy to his *Trachodon mirabilis*.

Diclonius calamarius, sp. nov.

This species, as represented by teeth, is the smallest of the genus, but the adult size is a point, however, not easily determined among extinct reptiles. The teeth are slender, and the front has parallel borders and a median keel. The borders are entire, and, in two of the crowns, twisted slightly round the long axis of the tooth. The keel is thus twisted also, and towards the base, when it becomes quite low, is nearer one border than the other. The back of the tooth displays two lateral facets, separated by a narrow median facet. The former have a thin, delicately rugose, cement investment, with a minute rugosity; the latter is smooth in the specimens, apparently from friction. The characters of this saurian readily distinguish it from its congeners.

Measurements.		M.
Length of portion of crown		.012
Diameter of crown	antero-posterior	.004
	transverse	.004

Monoclonius crassus, Gen. et sp. nov.

Char. Gen.—Teeth with obliquely truncate face and distinct root, which is grooved for the successional tooth on the front.

No external cementum layer, caudal vertebræ biconcave, and brim narrow. Fore limbs large and massive.

The teeth of this genus resemble those of *Hadrosaurus*, and like them, are replaced from the " front," an arrangement which precludes the possibility of more than one series of teeth being in functional use at one time. The robust fore limbs and elongate ilium distinguish *Diclonius* from *Hadrosaurus*. From *Trachodon* it differs in the absence of the rough cementum layer on the back of the tooth.

Char. Specif.—The faces of the teeth are acuminate oval in form, and are divided by an elevated keel, which is median above, but turns to one side at the base. Margin crenate, the grooves extending more or less on the convex "back," which is otherwise smooth.

Sacrum with ten vertebræ, the last centrum much compressed, the diapophyses extending horizontally from the neural arch above, and connected by a vertical lamina with the iliac supports; length 27.33 inches. The bones of the limbs are robust, the hinder the longer, but not so much so as in some other genera. Length of femur 22 inches; width, proximally, 7.4 inches; distally 6 inches. Length of tibia 20 inches; greatest diameter, proximally, 8 inches; distally 7.25 inches. The three anterior dorsal vertebræ are co-ossified, and the first exhibits a deep cup for articulation with the preceding vertebra. The episternum is a T-shaped bone, thin and keeled on the median line below. Length of transverse portion 21 inches.

Paronychodon lacustris, Gen. et sp. nov.

Char. Gen.—The teeth which characterize this genus have the general character of those of *Plesiosaurus*, *Elasmosaurus*, etc. The crowns are subconic, and the enamel is thrown into longitudinal plicæ. The special characters of the genus are seen in the form of the crown, one side of which is convex, and the other side plane, so that the section instead of being circular is semicircular. It is also strongly curved in the direction of its plane face.

Char. Specif.—Both anterior and posterior edges are curved, and are not acute nor denticulate. There are four plicæ on the flat face, only two of which approach the apex. There are six keels on the convex face, all of which approach the apex. All the carinæ are rather obtuse, and the enamel is otherwise smooth. The apex is very acute.

Measurements.

		M.
Length of tooth		.0130
Diameter at base	antero-posterior	.0040
	transverse	.0024
Length of crown		.0100

It is probable that portions of skeleton of this reptile are in my possession, but the means of positive identification are yet wanting.

Compsemys imbricarius, sp. nov.

This species, like the others of the genus, has the scutal sutures well defined, and the superficial surface of the carapace sculptured. The character of this sculpture distinguishes the species, and in the present instance in a special manner. It consists, in the *C. imbricarius*, of excavations bounded on the sides by a short ridge each, which alternate with each other. Thus each bounding ridge terminates abruptly at the fundus of one of the fossæ, while the other end of the fossa rises and contracts to another ridge. The result is precisely that seen in the interior sculpture of Saracenic domes or niches, and is one which is quite unique among tortoises. The direction of the ridges is at right angles to the costal dermal sutures. This species was about as large as the snapping tortoise (*Chelydra serpentina*).

Measurements.

		M.
Thickness of a costal bone		.0050
Three fossæ measure	lengthwise	.0065
	crosswise	.0050

Compsemys variolosus, sp. nov.

One of the most abundant, and the largest species of the Fort Union beds. The carapace is convex and the plastron flat; the marginal bones are heavy and strongly convex on the inferior side. The margin of the plastron is thickened and heavy, characters which also belong to all parts of the carapace. The sutures of the dermal scuta are deeply impressed, and the surface of the bone is strongly sculptnred above and below, and even on the superior face of the thickened margins of the free lobes of the plastron. The sculpture consists of round fossæ, which are deeply impressed and are arranged quincuncially, so that their borders never form straight lines. The latter are also more or less angulate on the edge, so that the surface has a more than usually rugose character.

The typical specimen equals those of the large land tortoises of the Eocene in dimensions.

Discovered by C. H. Sternberg.

Polythorax missuriensis, Gen. et sp. nov.

Char. Gen.—Plastron with contracted fixed lobes and wide bridge; carapace with well-developed marginal bones; mandibular ramus narrow; alveolar face with acute external margin; the symphysis neither produced nor recurred. Dermal scuta everywhere distinct, those of the plastron the usual ones, with the addition of the two marginal intergulars, and two large interhumerals. The latter scuta are separated from the humerals by sutures running parallel with the humeral margin of the anterior lobe between the gular and pectoral scuta.

In the possession of interhumeral scuta, *Polythorax* differs from any known genus of *Testudinata*. The general structure is much like that of *Adocus* and *Baëna*, with nearer resemblance to the latter in its double intergular scuta. It is impossible to ascertain whether there are intersternal bones, as the plastron is coössified throughout. The presence or absence of intermarginal scuta cannot yet be determined, although it is clear, that if existing, their position is quite external.

This genus is interesting as connecting in its stratigraphical position allied types of Cretaceous No. 5 (*Adocus*), with those of the Wahsatch and Bridger Eocenes (*Baëna*).

Char. Specif.—Carapace with openly dentate posterior border. The surface is irregularly swollen, especially on the median line near the margins of the vertebral scuta. The vertebral scuta are wide, the costals short, and the marginals narrow. The anterior lobe of the plastron is a little shorter and more contracted than the posterior; its base is narrower than the antero-posterior extent of the bridge. Its extremity is rounded, while that of the posterior lobe is truncate with rounded angles. The gular and intergular scuta are each wider than long, while the interhumerals are much longer than wide. The humerals are narrow while the pectorals are wide from the anterior position of the pectorohumeral suture. Each anal scutum is longer than wide.

The surface of the plastron is obsoletely but coarsely rugose; the roughness greatest anteriorly, where it consists of short raised lines irregularly disposed.

Measurements.	M.
Length of plastron	.183
Length of anterior lobe	.049
Length of bridge	.076
Width of bridge	.076
Width of extremity of posterior lobe	.035
Thickness at inguinal region	.010

Hedronchus sternbergii, Gen. et sp. nov.

Char. Gen.—The bone on which this genus reposes has the appearance of the crown of a young tooth. Its central cavity is large and expands to the margin of the basis; its apex is unworn. It appears to be too protuberant for the position of a dermal tubercle. It may be distinguished as a short crown on a shorter slightly constricted portion or neck. The crown culminates in three crests, which together form a letter T, and which descend towards the neck. There is no investment of enamel or cement, and the material of which it is composed resembles dense bone.

Char. Specif.—The faces on each side of the stem of the T, are concave and divided by an oblique crest, which descends from the common apex. The other face is gently convex, and the inferior part of each of its bounding crests projects ear-like. The base is an oval.

Measurements.		M.
Elevation of crown		.006
Diameter of base	longitudinal	.005
	transverse	.004

Discovered by Charles H. Sternberg.

Ceratodus eruciferus, sp. nov.

A basal lamina separable from the dentigerous lamina. The latter supports ribs which diverge from a single marginal rib which extends along one side. The marginal rib is separated by a deep groove from the radiating ribs, which is continuous with the grooves between the latter. The ribs are of irregular diameter and not perfectly straight; they are interrupted by weak transverse ridges which project beyond the margins. The ridges rises abruptly from their common base and are separated distally by notches of the margin.

Measurements.	M.
Long diameter of dental surface	.011
Short diameter of dental surface	.007
Thickness of plate	.003

There are six ridges in the length.

Ceratodus hieroglyphus, sp. nov.

This species is materially different from the last, and was more abundant, judging from the occurrence of its remains.

The dentigerous plate is thin and dense, and has the appearance of a short toothed comb with a handle. The tooth-like points are the extremities of low ridges, which are arranged nearly at right angles to a wide longitudinal elevated half of the osseous base. They are separated by shallow grooves from each other, and are not continuous with the basis just mentioned, which rises abruptly above them. They are smooth. The "handle" above alluded to is triangular in section having two bevels on the side supporting the tooth ridges. The lower face of the bone is smooth.

Measurements.	M.
Total length	.013
Length of dentigerous portion	.010
Total width	.0045
Width of dentigerous portion	.0020

There are thirteen teeth in the length.

Myledaphus bipartitus, Gen. et sp. nov.

Char. Gen.—Crowns of the teeth molar in character, truncate, wider than long, standing table-like on the root. The latter partaking of the shape of the crown, short, straight, split equally and at right angles to the greatest diameter of the tooth. The crowns form a pavement having a regularly hexagonal outline. Their composition is different in the halves on each side of a line which divides the crown equally, running in the long direction. On one side the dentine is striate at right angles to the long diameter; the structure is not distinguishable by the hand lens on the opposite side of the line.

The affinities of this genus cannot now be stated, but the form of the root recalls the *Elosmobranchii*, and that of the crown, some of the rays.

Char. Specif.—The staining on opposite sides of the line that divides the crown, is different, on the one paler than on the other.

The face of the crown is nearly plane, and its border is vertical and overhangs the root all round in a narrow ledge; it is vertically striate, as is also the root. The antero-posterior diameter exceeds the transverse, and the facets are subequal, and are continued less perfectly on the root. The fissure of the latter does not reach the base of the crown.

Measurements.		M.
Length of tooth		.0053
Diameter of crown	antero-posterior	.0060
	transverse	.0045
Long diameter of root		.0050
Length of root		.0030

Discovered by Charles H. Sternberg.

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ON SOME EXTINCT REPTILES AND BATRACHIA FROM THE JUDITH RIVER AND FOX HILLS BEDS OF MONTANA.

BY E. D. COPE.

LÆLAPS, Cope.

Proceed. Acad., Phila., 1866, p. 275. Extinct Batr. Rept. N. Amer., 1869, p. 100.

Two species of this genus were described in the latter memoir above cited, the *L. aquilunguis*, Cope, and *L. macropus*, Cope, both from the greensand or Fox Hills group of the cretaceous of New Jersey. A considerable portion of the skeleton of the former was described, including the peculiarities of the ankle-joint, which led me to the conclusion, previously unsuspected by naturalists, that the *Dinosauria* present affinities to the cursorial birds. The teeth of this species were described and figured, but in the *L. macropus* they were, and still remain, unknown.

In a preliminary report on the extinct vertebrata obtained by the writer on the Upper Missouri the present year, three additional species were referred to this genus, viz.: the *Lælaps incrassatus; L. explanatus*, and *L. falculus.* Their characters were ascertained from teeth alone, so that their pertinence to the genus *Lælaps* is not fully assured. A fourth species of carnivorous dinosaurian was described under the name of *Aublysodon lateralis.*

One of the most valuable specimens obtained by my expedition of 1876, is the nearly entire left dentary bone of the *Lælaps incrassatus*, which exhibits the teeth of its two extremities. The different forms of the teeth of the carnivorous *Dinosauria* graduate into each other by such easy stages, as to have given rise to question in reference to their proper interpretation; whether they indicate different species or only different positions in the dental series. In describing the *Aublysodon horridus*, the first known of the species of the Judith River beds, Dr. Leidy expressed the suspicion that a certain form characterized the teeth in the position of incisors, another those in the position of canines, and another form the remainder of the series. The teeth of the last kind have the form of those of *Lælaps;* in others the posterior serrulate cutting edge is

latero-posterior, the posterior aspect being thickened, and either transverse or convex in section. In the supposed canines the anterior serrulate edge is wanting, or represented by a second posterior edge parallel with the original one, thus forming a compressed chair-shaped crown. Numerous specimens of all these forms were obtained by the expedition.

Examination of the dental series of the *Lælaps incrassatus* shows that the antero-posterior diameter of one or two teeth in the position of canine, becomes oblique in the curved long axis of the dentary bone. The transverse diameter is also greatly increased so as to equal or even exceed the antero-posterior; the serrate edges are opposite to each other. A tooth of this type was the first of this species which I observed, and the name has reference to its peculiar form. A tooth in the position of first or anterior incisor, differs in having the anterior serrate crest removed to the middle of the inner aspect of the apical portion of the crown, while tbe posterior edge retains its usual position. Further posterior transfer of the anterior cutting edge and a grooving of the posterior face, would produce a tooth of the form suspected by Leidy to be the canine of *Aublysodon horridus*, while the canine just described is different from any tooth referred by Leidy to the same species. But a large tooth found in immediate association with the jaw, but separated from it, has the posteriorly truncate form described by Leidy as typical, and is very probably the tooth of the maxillary bone, near the position of the superior canine of a mammal.

It may be observed in conclusion, that if the teeth suspected by Leidy to be canines of *Aublysodon horridus*, but which I suppose to be incisors, are really such, *Aublysodon* must be regarded as a genus distinct from *Lælaps;* while, on the other hand, should such determination prove to be inadmissible, and the two genera be the same, the name *Lælaps* must be preserved as the older; it was published in 1866, while *Aublysodon* bears date 1868.

In examining the very numerous teeth discovered by the expedition, I find four species in addition to those already named. A list of all the species is now given.

Lælaps incrassatus, Cope, Proceed. Acad. Nat. Sci. 1876, Oct.

The dentary bone of this species, above alluded to, is of compressed form, and becomes thin and plate-like in its posterior portion. The latter is excavated on the inner side, where it is proba-

bly applied to the opercular and surangular bones, if they exist, and a large foramen is continued from the concavity into the remaining part of the dentary, as a tubular canal. Above the foramen there originates a groove which runs parallel to the inner alveolar border to the posterior edge of the symphysis. The latter is short, and scarcely distinguished from the other surfaces; the attachment of the rami was evidently ligamentous and more or less movable. The anterior alveolar portion of the ramus is produced, so that the symphysis slopes backwards below. The inferior border of the dentary bone is gently concave behind its middle. It is throughout convex in the transverse direction.

The external alveolar wall is an inch higher than the internal. The inner portions of the septa are apparently subject to exfoliation and subdivision in connection with the renewal of the teeth as a groove which is continuous with the inner alveolar borders, cuts them off from the other interior surface of the dentary bone. The external face of the dentary is in general plane, but is variously excavated along its superior border. An inch below the latter there extends a series of large foramina, each one of which is situated opposite to an interalveolar septum. They are more numerous anteriorly, a foramen being opposite each alveolus as well, and each foramen is connected with the border by a shallow groove. Similar foramina extend down the outer side of the symphyseal border, and along the inferior border of the dentary for two-thirds of its length. The same proportion of the external face is obsoletely rugose through the presence of delicate lines of growth. Such lines extend on the lower part of the interior face obliquely upwards and backwards.

There are alveolæ for fifteen teeth in the dentary bone. Of these only the second, third, fourth, fifth, twelfth, and fifteenth contained teeth capable of functional use at the time the jaw was inclosed in the lacustrine mud. Successional teeth occupy the first, tenth, and twelfth, but no two teeth are in an identical stage of protrusion. The section of the crown from and including the fourth to the last is nearly equilaterally lenticular. Their surface is smooth.

Measurements.		M.
Length of entire dentary bone		.525
Depth at posterior border of symphysis		.110
" " last tooth		.192
" to internal groove		.060
" " " foramen		.074
Length of crown of second tooth		.029
Diameter of second tooth at base	antero-posterior	.013
	transverse	.018
Length of crown of twelfth tooth		.043
Diameter at base of twelfth tooth	antero-posterior	.025
	transverse	.017
Length of crown of superior ?canine		.062
Antero-posterior diameter of do.		.028

As compared with the *Lælaps aquilunguis*, of which a portion of the dentary bone is known, this species differs in the greater diameter of its inferior border anteriorly, in the presence of the internal groove, in the greater elevation of the external alveolar wall, and, if the character be constant, in the greater robustness of the form of the dental crowns. The individual here described is rather larger than the type of *L. aquilunguis*, but it is probable that the species were not very different in dimensions.

Lælaps hazenianus, sp. nov.

Seven teeth from different localities present constant characters which readily distinguish them from all other species of the genus. Their size is less than those of the two species above mentioned, and is greater than in the species enumerated below.

The crowns are short and robust, and are abruptly terminated by the strong recurvature of the anterior cutting edge. The apex has, therefore, a more posterior direction than in the *L. incrassatus*, while the anterior cutting edge is shorter. The latter is shortened below also, not extending to the base of the enamel, but terminating in a short lateral curvature. At the base, therefore, the anterior border is rounded, while the posterior is acute. The denticulations are of medium size, measuring M. .00033.

Measurements.		M.
Length of crown		.014
Diameter of crown	antero-posterior	.011
	transverse	.007

Both sides are convex, but not equally so, and the surface is smooth, and without facets.

This saurian is dedicated to General Hazen, now in command at Fort Buford, Dakota, as a token of respect for his qualities as a man and his services in the interest of science.

Lælaps lævifrons, sp. nov.

A tooth half the size of those referred to the *L. hazenianus*, and exceeding by a little the largest of those of *L. explanatus*, presents such characters as induce me to believe that it belongs to a species distinct from either. It is of the elongate acuminate form of some of those referred to the *L. incrassatus*, and both sides are convex, but not equally so. A shallowly concave plane occupies the middle of the more convex side. The posterior cutting edge is denticulate to the base, but the anterior, though of the same form as in the other species, and unworn, is absolutely smooth. In this respect it differs from the other species, excepting *L. falculus*. The denticulations are finer than those of any other species, measuring M. .00020; in *L. explanatus* they measure M. .00022.

Measurements.		M.
Elevation of crown		.015
Diameter of crown	antero-posterior	.007
	transverse	.004

Lælaps explanatus, Cope, Proceedings Academy, October, 1876.

Lælaps falculus, Cope, loc. cit.

Lælaps cristatus, Cope, sp. nov.

Another small species well distinguished by the form and coarse denticulation of the teeth, approaching the genus *Troödon*.

The crowns of the teeth are short, stout, compressed, and curved. Both sides are convex, and neither is facetted. The denticles are large, those of the posterior cutting edge the largest, and measuring M. .0005. A characteristic feature is the full development of the denticulate anterior cutting edge of the crown. This extends to the base, becoming more prominent as it descends. Surface smooth.

Measurements.		M.
Elevation of crown		.011
Diameter of crown	antero-posterior	.006
	transverse	.003

ZAPSALIS, Cope.

The teeth of this genus are intermediate in form between those of *Lælaps* and *Paronychodon*. They have one flat and one con-

vex side, whose junctions form the anterior and posterior edges of the crown, as in the latter genus; and like the latter, there is no anterior cutting edge, but instead, a solid angle. But the posterior edge is denticulate as in *Lælaps*, and the plicæ or keels of *Paronychodon* are here only recognizable in low angles. Some light may be cast on the affinities of the latter genus by the discovery of *Zapsalis*.

Zapsalis abradens, sp. nov.

This reptile was apparently about the size of the *Lælaps lævifrons*. The best preserved tooth is that of a probably adult animal, as it displays considerable attrition, especially on the flat side. Here three worn lines indicate the former existence of as many low longitudinal angles of the surface, of which the median is basal and short. The convex side exhibits four low angles of nearly equal length, all stopping short of the apex. The facets between them, excepting the anterior two, are slightly concave. The denticles are of moderate coarseness, measuring M. .00033.

Measurements.		M.
Elevation of crown		.0120
Diameter of crown	antero-posterior	.0065
	transverse	.0030

URONAUTES, Cope.

Genus novum Sauropterygiarum. Cervical vertebræ, like the dorsals and caudals, short and transverse, and distinct from each other. Neural arches and transverse processes coössified at maturity. Transverse processes of the cervicals simple and depressed. Extremities plesiosauroid.

This genus might be referred to *Polycotylus*, Cope, were it not for the distinctness and greater abbreviation of the cervical vertebræ. From *Cimoliasaurus*, Leidy, it differs in the coössification of the caudal diapophyses and the much greater abbreviation of the cervical vertebræ. The centra are amphiplatyan in *Cimoliasaurus*, biconcave in *Uronautes*. From *Pliosaurus*, Owen, which resembles the present form in the shortness of the cervical vertebræ, the coössified transverse processes of the cervicals separate it. The present is pre-eminently a short-necked genus of the order.

The remains on which it reposes are the cervical, dorsal, and caudal vertebræ, with portions of limb and rib bones.

Uronautes cetiformis, sp. nov.

The cervical vertebra of this species is of unusual form, being short and transverse, and not wider than deep. In *Polycotylus latipinnis* this vertebra is much wider than deep, and as long as wide. The neuropophyses are compressed so as to be antero-posterior, and they inclose a rather wide neural canal. The parapophyses are directed equally downwards and outwards, occupying the position of the angle of a subquadrate outline, since the sides are nearly vertical. The articular faces are slightly concave, and the centrum is perforated vertically by the usual two foramina.

A dorsal vertebra found in immediate proximity to the cervical just described is much like that of the *Polycotylus latipinnis*. That is, it is exceedingly short antero-posteriorly, and has concave articular faces, the concavity with flat fundus, and marked with a few obscure concentric grooves. The sides are also slightly concave, and are pierced with a foramen at the superior portion. The vertical foramina are also present. The neural arch is in this specimen separated from the centrum, not having become coössified. This circumstance might lead to a doubt as to the proper reference of the specimen to this animal, but such doubt has little foundation. In one of the caudal vertebræ one of the diapophyses is coössified, and the other is not. The suture of the surface thus exposed is of a very fine texture, and evidently not like that seen in the genera where it is to act as a permanent articulation. In the case of the dorsal vertebra, the suture for the neuropophysis has the same character. This vertebra is much larger than the cervical, but does not much exceed the proximal caudal in size; preserving the relations seen in the *Polycotylus latipinnis*. Adjoining the border of the fossa of the neuropophysis is a small parapophysial tuberosity.

A proximal caudal vertebra has a very small fore and aft diameter, and the vertical exceeds the transverse diameter. The diapophyses spring from the middle of the sides of the centrum, while the inferior face is separated from the inferior lateral faces by an obtuse longitudinal angle. In general, the form is that of a transverse hexagon. The chevron facets are very slightly developed. Another probably distal caudal vertebra considerably resembles that in the corresponding part of the skeleton of a cetacean. It is without neural arch, transverse, flat below, and

with the two lateral faces of unequal length, the superior being the longer. The vertical perforating foramina join at the neural canal, and there is a short subquadrate plane on each side of the latter. There are no indications of chevron facets. These vertebræ are different from any of those yet known in *Polycotylus*.

Measurements.		M.
Diameter of a cervical centrum	antero-posterior	.016
	vertical	.026
	transverse	.029
Diameter of a dorsal	antero-posterior	.030
	vertical	.055
	transverse	.056
Diameter of a proximal caudal	antero-posterior	.022
	vertical	.040
	transverse	.062
Diameter of a distal caudal	antero-posterior	.015
	vertical	.017
	transverse	.038
Diameter of neural canal of the proximal caudal above measured		.012
Do. of diapophysis of do. at base		.018

The distal end of a proximal limb bone is much like the corresponding part of *Polycotylus latipinnis*. It is relatively of large size, flat, and strongly convex at the extremity, which is not transversely truncate. A portion of another limb bone, perhaps belonging to the distal segment, is symmetrical. The shaft is broken off, and displays a large medullary cavity, with thin walls, which soon terminates towards the articular end, in a fundus with a fissure in the bottom. The proximal portion of a rib has a truncate head of an oval outline. The inferior border presents a low tuberosity, which may represent the capitulum.

Measurements.		M.
Width of distal end of proximal limb bone		.109
Thickness of the same		.032
Diameter of proximal end of a rib	longer	.030
	shorter	.028

The bones above described were found together by the writer, on a slope of the cream-colored soft sandstone, which lies above the black shales of Cretaceous No. 4, near Amell's Creek, Montana. I suppose the formation to be the No. 5, or Fox Hills group of Meek and Hayden. Near them were found shark's teeth

of the genera *Otodus* and *Lamna*, and a species of *Enchodus*. Above them I found lying loose a fragment of a *Baculites*.

CHAMPSOSAURUS, Cope.

Genus novum. Vertebræ of more than a hundred individuals referable to several species, which I obtained from the Judith River beds of the Upper Missouri region, present characters which demand the establishment of a new genus for their reception.

The characters presented by the vertebral column are the following: The ribs have a single head, which articulates with a prominent tuberculum, excepting those of the cervical vertebræ. On these there is a small capitular tubercle below the diapophysis. It commences very small, and inferior in position, being removed, in fact, but a short distance from the inferior middle line in the first vertebra in which it appears. It rises rapidly in the succeeding centra until it is merged in the tuberculum of the diapophysis. The latter projects from the neural arch, which is free from the centrum, but in none does the base of the diapophysis rise from a point above the floor of the neural canal. On the dorsals it is vertically compressed. One of the anterior cervicals, probably the axis, is obliquely truncated below its anterior articular face, for a free hypopophysis or *os odontoideum.* This vertebra has no parapophysis, and the articular faces for the neuropophysis are superior. The few vertebræ in each of several series, probably from the sacral region, are more depressed than the others, and the facets for the diapophyses present a greater antero-posterior extent, but none are coössified. The caudal vertebræ are distally quite compressed. In all, except the anterior ones, the neural arch is coössified with the centrum, and in such there are no diapophyses. In those with free neural arch, the facets for the neuropophyses turn down on the sides of the centrum.

The articular extremities of the centra are plane, those of the caudal series slightly concave. There are no hypapophyses behind the axis, excepting a longitudinal carina, which ceases to exist on the dorsal vertebræ. The zygapophyses are simple. The chevron bones are free.

The relations of the atlas and axis, though not fully elucidated by my specimens, are peculiar. The former has separate neurapophyses, which have nearly the shape of those of the Streptostylicate *Reptilia*, resembling much those of the *Pythonomorpha*.

Although I procured numerous cervical vertebræ, there are but few which exhibit the antero-inferior facet for supposed hypapophysis, already described. The position of this vertebra was in front of the first cervical which displays a parapophysis, and is, on this account, likely to be the axis or the third cervical vertebra. It is the more probably the axis, as there is no other among the large number of vertebræ in my collection which can be referred to that position. Its anterior articular face is smooth and like the posterior, showing that the odontoid bone was not coössified with *it*. Now in the *Crocodilia* the odontoid bone is united with the anterior extremity of the axis by suture, which may become coössified with age, while the free hypapophysis is wanting. In the streptostylicate orders the hypapophysis is present, and the odontoid is above it, but united to the axis by suture. On the other hand, in the *Rhynchocephalia*, the axis is coössified with both odontoid and hypapophysis, and a few succeeding vertebræ possess free hypapophyses. Thus it is possible that I am yet unacquainted with the axis of *Champsosaurus*.

One entire rib and the heads of several others are all that were obtained. The former is from the anterior part of the dorsal series, and is stout and short. The head is truncate and compressed, its articular face is contracted, forming a narrow figure eight. The shaft is obliquely flattened. The extremities are separated from the lateral surfaces by a narrow angle, as though capped with cartilage in life, as in the *Pythonomorpha.*

Bones of the extremities are very rare. One fragment resembles the proximal end of a crocodilian tibia, and another is like the distal half or more of the tibia of the same type.

There is considerable resemblance between the vertebræ of this genus and those of *Hyposaurus*, Ow., from Cretaceous No. 5, of New Jersey, but the relations of the axis and atlas in that genus are as in other *Crocodilia*, and not like those seen in *Champsosaurus.* The absence of sacrum precludes the possibility of regarding this form as dinosaurian. It rather seems to share some rhynchocephalian characters with general amphiplatyan crocodilian resemblances. The shortness and robustness of the thoracic ribs is a feature quite unique, and reminds one of the *Batrachia.* The teeth are unknown in their true relations, but there are several types in the collections which may be found to belong here. These are of the rhizodont character.

As a summary of the preceding, I propose to refer the genus *Champsosaurus* to the order *Rhynchocephalia*, provisionally. It differs very much from the typical genus of that order, *Sphenodon*, in the non-coössification of the sacral vertebræ, and non-union of the neural arches of the vertebræ with their centra, and the absence of the chordal perforation of the latter. It differs from the extinct genera *Clepsydrops* and *Cricotus*, Cope, in the last mentioned two characters. On these grounds it may constitute a distinct suborder, under the name of *Choristodera*.

It is possible that the tooth, which I referred to a new genus and species, under the name of *Paronychodon lacustris* (Proceedings Academy, 1876, October), may belong to one of those of the present genus. In that case the older generic name takes precedence of the later. I may add that some vertebræ of this genus have been figured and described by Dr. Leidy in the Transactions of the American Philos. Society, 1860, without name.

I recognize four species among the vertebræ, chiefly by characters observed in the cervical region. There is a great discrepancy of size among them, and the small ones may be immature.

Champsosaurus profundus, sp. nov.

This species is chiefly known from a series of vertebræ found together, and having every appearance of pertaining to the same animal. It consists of a cervical, three dorsal, and a sacral vertebræ. Other isolated vertebræ of several individuals present similar characters.

The primary feature is the great vertical diameter of the dorsal vertebræ as compared with the transverse measurement. This is occasioned by the great development of the inferior keel, to which the sides of the centrum converge, without concavity. In corresponding centra of the *C. annectens* the inferior face is merely angulate. Another character is the obliquity of the articular faces to a vertical plane drawn at right angles to the long axis of the centrum. This is most strongly marked on posterior dorsals, where the inferior keel is less prominent. The sacral vertebra has a depressed form.

An anterior caudal vertebra may belong to this or an undescribed species. It has rudiments only of the chevron-facets, and having a large neural arch, is doubtless from the anterior part of the series. It is more compressed than the corresponding one in *C.*

annectens, and has an acute inferior angle, which is wanting in the latter.

Measurements.

No. 1.

		M.
Diameter of cervical centrum	longitudinal	.020
	vertical	.020
	transverse	.018
Diameter of anterior dorsal centrum	antero-posterior	.020
	vertical	.022
	transverse	.019

No. 2.

Diameter of posterior dorsal centrum	antero-posterior	.023
	vertical	.019
	transverse	.019

Champsosaurus annectens, Cope, sp. nov.

The greater number of vertebræ obtained belong to this saurian, which may therefore be looked upon as the type of the genus.

The cervical which bears the hypapophysial facet presents a carina below, which is only prominent between the articular faces. One such cervical in the collection is rounded below, and may be anterior in the series, or may belong to another species. The inferior keel is strong on the other cervicals, but soon disappears on the anterior dorsals. The remaining centra are rounded below. The parapophyses where present are knob-like, and the corresponding part of the transverse process is similar in the anterior dorsal vertebræ. The base of the neural arch is nearer the anterior than the posterior articular face. These faces are nearly round in the anterior caudal centra, but soon become vertical ovals, with the compressed form. There is a fossa below and in front of the parapophysis, which continues to beyond the anterior dorsals. The dense layer of the surface of the centrum is smooth, except some delicate striations near the articular borders. These are most marked along the median inferior face of the caudal vertebræ, which is flat, grooved, and distally acute.

I cannot certainly connect the vertebræ of a series as those of a single individual.

Measurements.

No. 1.

		M.
Diameter of a cervical with hypapophysis	antero-posterior	.023
	vertical	.021
	transverse	.020

			M.
No. 2.			
Diameter do. without hypapophysis	antero-posterior	.	.017
	vertical	.	.0165
	transverse	.	.017
No. 3.			
Diameter do. without hypapophysis	antero-posterior	.	.011
	vertical	.	.0105
	transverse	.	.011
No. 4.			
Diameter of an anterior dorsal	antero-posterior	.	.023
	vertical	.	.023
	transverse	.	.023
No. 5.			
Diameter of an anterior dorsal	antero-posterior	.	.008
	vertical	.	.0072
	transverse	.	.0075
No. 6.			
Diameter of a sacral centrum	antero-posterior	.	.010
	vertical	.	.009
	transverse	.	.009
No. 7.			
Diameter of an anterior caudal	antero-posterior	.	.083
	vertical	.	.053
	transverse	.	.058
No. 8.			
Diameter of a median caudal	antero-posterior	.	.017
	vertical	.	.011
	transverse	.	.011
No. 9.			
Diameter of a posterior caudal	antero-posterior	.	.014
	vertical	.	.0086
	transverse	.	.007

A vertebra not distinguishable from the corresponding one of this species was found near Amell's Creek, on a bank of deposit of the Fox Hills group (No. 5), with the bones of the *Uronautes cetiformis*, supra. I cannot account for this circumstance, as it is the most abundant fossil of the Judith River beds (No. 6).

Champsosaurus brevicollis, sp. nov.

On one occasion the writer discovered a number of vertebræ of this genus close together, and in such relation as to induce the belief that some of them belonged to the same individual. Parts of several were obtained, however, adding another evidence of the

manner in which the fossils of this formation have been dislocated and scattered. The evidence for the existence of this species must be allowed to rest at present on a cervical vertebra, with free hypapophysis. This body differs from the corresponding one in the *C. annectens* in its greater brevity as compared with its length. The vertical and transverse diameters exceed the longitudinal in the *C. brevicollis*, while in the *C. annectens* the length exceeds both. The inferior aspect of this centrum is broadly rounded, not carinate as in *C. annectens.* The value of this character is uncertain, but a centrum similarly rounded below (above alluded to) has the more elongate form of the *C. annectens.*

Measurements.

		M.
Diameter of centrum	antero-posterior	.013
	vertical	.014
	transverse	.015

Champsosaurus vaccinsulensis, sp. nov.

This reptile is indicated by a posterior dorsal vertebra in which the common base of the neural arch and diapophysis is decurved to below the middle of the side of the centrum. This surface has somewhat the outline of the section of a T-rail, the inner portion being on the superior face of the centrum. The centrum is shorter than the corresponding ones of the *C. annectens* and *C. profundus*, so that the basis of the neural arch approaches near the borders of the articular faces above. The centrum is perforated by two vertical foramina as in most *Sauropterygia.* The osseous tissue of the bone is quite dense, and the surface is smooth.

Measurements.

		M.
Diameter of centrum	antero-posterior	.026
	vertical	.029
	transverse	.045

Besides the much larger size, this species differs from those previously referred to this genus in almost all details of proportion, etc.

SCAPHERPETON, Cope.

Genus novum Batrachiarum. Vertebræ deeply biconcave, with opposed, but not continuous, foramina for the chorda dorsalis. Neural arch with zygapophyses, and well-developed neural spine. Centrum with vertically compressed, short diapophysis

near the posterior extremity, a prominent hypapophysial keel, and prolonged neural spine. Supposed proximal limb bone with a branch-like trochanter. Supposed teeth in several rows, attached in shallow alveoli, those of the marginal series larger; the crowns obtusely conic and simple.

In the above diagnosis are expressed the general characters of a genus of probably tailed *Batrachia* which has left remains of several species in the Judith River beds of the Upper Missouri region. Although the vertebræ resemble no little those of *clepsydrops*, Cope, a rhynchocephalian lizard from supposed triassic or permian formations, the atlas is that of a batrachian. The limb bone probably belonging to it, is unlike that of any genus of the *Proteida* or *Trachystomata*, differing also from that of *Menopoma*, but approaching nearly that of the typical salamanders. The diapophyses are different in form from those of the *Trachystomata Proteida* and *Amphiumidæ*, but resemble in their vertical compression those of *Menopoma*. They are generally broken in the specimens, but where preserved, are much shorter than in that genus, being even less produced than in most of the recent salamanders. The prominent keel of the median line below is not found in salamanders, and it has no posterior prolongation resembling the structure seen in *Amphiuma* and *Cæciliidæ*. The produced neural spine is a character not found among tailed *Batrachia*, and the posterior direction which it takes reminds one of the *Dinosauria* more than anything else, and is not like the form seen in *Lacertilia*. It is a prolongation of the roof-like extension of the neural arch seen in some of the tertiary salamanders of France.

The structure of the proximal limb bone, and the form of the diapophyses of the vertebræ refer this genus with much probability to the *Urodela*. The produced neural arch, and the probably complex disposition of the teeth, indicate a family different from any of those now living. The biconcave centra place it nearest to the *Amblystomidæ*.

The teeth above mentioned are attached to a fragment of a jawbone. The crowns are all imperfect, and mostly broken off. There are three series of smaller teeth and a marginal series of teeth of one half greater diameter. They exhibit a moderate pulp cavity, and the superficial investment of the crowns is not inflected. It has a minute granular rugosity, and the bases of the teeth are rugose

with impressed punctæ. The teeth are described here because it is not known to which species they belong. It is, indeed, not certain, but only probable, that they belong to this genus.

Four atlases preserved indicate two species; one being more depressed than the other three, and the anterior cotyli therefore more transverse.

The vertebræ indicate four species. It is probable that they present some pecularities at different points in the same column, the caudals at least differing in some degree from the others. The characters of the species are quite well marked.

Scapherpeton tectum, sp. nov.

Represented by a vertebra which is one of the best preserved in the collection. The most prominent specific character is seen in the entire roofing over of the neural canal between the anterior zygapophyses, and in the downward production of the inferior median line of the centrum, and accompanying downward prolongation of the articular cups. The chordal perforation is at the superior fourth of the vertical diameter of the cups. The neural spine is produced backwards and curved upwards, and is narrowed between the posterior zygapophyses, and is striate grooved on the under surface. About half of the posterior zygapophysis projects beyond the edge of the cup of the centrum. Immediately below the anterior edge of the posterior zygapophysis, the diapophysis begins. It is vertical, of an irregular figure 8 in section, and is directed outwards and backwards. A foramen passes under its middle, emerging a little before the middle of the same horizontal diameter of the centrum. It is joined by another which strikes it from below at right angles. There is a deep notch embraced between the superior part of the diapophysis and the posterior zygapophysis. The neural canal is wider than deep.

A fragment accompanied this vertebra when found, which resembles the articular portion of the mandible. There is no angle projecting behind the quadrate facet, which is oblique, truncating the extremity of the ramus. The lower edge is acute, behind roughened, and a thickening extends along the middle of the inner side of the ramus so far as preserved. The character is that of a Urodele Batrachian.

Measurements.		M.
Diameter of centrum	antero-posterior	.0875
	vertical	.0750
	transverse	.0500
Vertical diameter of diapophyses		.0500
Transverse diameter of neural spine between posterior zygapophyses		.0500
Depth mandibular ramus at front of quadrate cotylus		.0800

Scapherpeton laticolle, sp. nov.

Vertebræ of several individuals of smaller size than those referred to the *S. tectum* differ in the less extensive development of the roof connecting the anterior zygapophyses, and the greater compression of the centrum, in consequence of the downward production of the inferior keel. The neural arch is openly notched between the anterior zygapophyses, but the notch is bounded by a recurved lamina distinct from the zygapophyses. The diapophyses are much as in *S. tectum*; the ridge from the inferior portion of it is quite prominent, and includes with the base of the neural arch a deep fossa.

Accompanying a dorsal vertebra like those of this species, and probably belonging to the same skeleton, is an atlas of a more depressed form than those presumably belonging to the other species. The median tuberosity is well developed, constricted at the base, and much flattened. The condyloid facets are narrow and transverse.

Measurements.		M.
Diameter of dorsal centrum	antero-posterior	.070
	vertical	.050
	transverse	.030
Width of the neural canal		.020
Vertical diameter of base of diapophysis		030

If it should appear that the dorsal vertebræ do not represent a species distinct from the *S. tectum*, the *S. laticolle* may rest on the atlas described.

The limb bone above mentioned is associated with the neural arch of a vertebra of the character ascribed to this species. Both extremities are eroded so as not to display the forms of the condyles, though almost the entire length is preserved. The trochanter is imperfect, but its base is that of a subcylindric process. The head of the bone is subtriangular, and the section of the

2

distal end an oval with a flat side. The diameter contracts gradually to the middle.

Measurements.		M.
Length of bone		.0150
Diameter	proximally	.0036
	medially	.0019
	distally	.0037

This bone is plainly that of a urodele salamander.

Scapherpeton excisum, sp. nov.

This salamander is represented in the collection of the expedition by vertebræ of three individuals of different sizes. They all agree in having the anterior zygapophyses separated by the concave excavation of the roof of the neural canal usual in ordinary salamanders, and in the moderate development of the hypapophysial keel. As a result, the articular extremities of the centra are not produced so far inferiorly as in *S. laticolle.* The longitudinal ridge from the inferior part of the diapophysis is pronounced, and separates a deep fossa above it from another below it. The longitudinal perforation of the base of the diapophysis issues in the superior fossa, while in the two smaller specimens a vertical perforation joins it from the inferior fossa. As in the preceding two species, one articular face is a little deeper than the other.

Measurements.		M.
Diameter centrum No. 1	longitudinal	.009
	vertical	.006
	transverse	.005
Width of neural canal do.		.003
Depth " "		.0015
Diameter centrum No. 2	longitudinal	.0060
	vertical	.0033
	transverse	.0030

Specimen No. 1 is as large as the corresponding portion of an *Amphiuma means.*

Scapherpeton favosum, sp. nov.

The vertebra which I select as typical of this species is more distinct in character from those of the three species above described, than they are from each other. Although the centrum presents a strong inferior keel, its border is not horizontal or convex, but concave, and the articular cups are proportionally little elongated downwards. The diapophyses have at their bases a

relatively small vertical diameter, and the longitudinal perforation enters below and before the base and not behind it. The longitudinal ridge from the inferior part of the latter is very prominent and horizontal, bridging over the vertical perforation, which enters the superior lateral fossa. It is separated below from the posterior perforation by a short oblique bridge. The neural arch is lost from this specimen.

There are other vertebræ which display a slightly developed inferior keel, and articular cups little produced downwards, but the fossæ are less developed than in the one described.

Measurements.		M.
Diameter of centrum	antero-posterior	.006
	vertical	.004
	transverse	.003

The typical individual was about as large as the *Menopoma.*

HEMITRYPUS, Cope.

Represented by a vertebra of the general character of those of the genus *Scapherpeton*, but which lacks the foramen chordæ dorsalis of the posterior half of the centrum, and is not carinate on the inferior surface. The diapophysis is directed backwards just below the posterior zygapophysis, inclosing with it a notch into which the anterior zygapophysis is received. Anterior zygapophyses connected by a prolongation of the neural arch.

I had suspected that this vertebra might be one of those of the cervical region of a species of *Scapherpeton*, but the position of the foramen chordæ dorsalis renders this highly improbable. The only position to which it could be assigned in the column of this genus would be that of the axis. But the foramen is present in the posterior half of the atlas and thus probably in the axis in *Scapherpeton*, as in vertebræ from all other regions of the column, so that such an exception as is presented by the present centrum is not to be looked for. The absence of the carina, and the cylindric form of the centrum, add to the belief that the species does not belong to *Scapherpeton.*

Hemitrypus jordanianus, Cope, sp. nov.

No emargination between the anterior zygapophyses; neural spine directed upwards and backwards. The diapophyses vertically compressed, directed downwards, inwards, and backwards,

and not giving origin to a strong ridge on the side of the centrum, as is seen in the species of *Scapherpeton*. Neither is there any fossa on the side of the centrum as in that genus. There is a small longitudinal foramen which enters the inner base of the inferior half of the diapophysis. There is a low ridge on each side of the neural arch, which extends backwards and inwards. The anterior articular face is a wide oval somewhat contracted below, and is pierced by a foramen at a point within the superior third of the vertical diameter. It is not so deeply excavated as in the species of *Scapherpeton*. The posterior articular face is a regular vertical oval, is concave, but not excavated, as is seen in the centra of the genus just mentioned. The inferior face of the centrum is rounded, with some feeble lateral ridges.

Measurements.

		M.
Diameter of centrum	longitudinal	.0070
	vertical	.0050
	transverse	.0040
Total elevation at middle		.0090
Expanse of posterior zygapophyses		.0070
" " "	diapophyses	.0095

About the size of the *Menopoma allegheniense*.

This batrachian is dedicated to Prof. D. S. Jordan, of the Northwestern Christian University, author of the Manual of the *Vertebrata* of the Eastern United States.

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Cope, E. D.

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PALEONTOLOGICAL BULLETIN No. 24.

A continuation of Researches among the Batrachia of the Coal Measures of Ohio.

By E. D. Cope.

(*Read before the American Philosophical Society, February* 3, 1877.)

The material described in the following pages was obtained from the coal strata at Linton, Ohio, during the Summer of 1876, by Prof. J. S. Newberry, Director of the Geological Survey of Ohio.

Ichthycanthus ohiensis. Cope. Gen. et sp. nov.

Char. Gen. These are derived from the posterior dorsal and caudal vertebræ, with adjacent parts. Posterior limbs well developed, with distinct tibia and fibula, osseous tarsus, and probably five digits. Ribs elongate, simple, curved. Abdominal armature consisting of bristle-like rods in anteriorly directed chevrons. Dorsal vertebræ not elongate, with simple neural spines. Tail large, its vertebræ ossified, and furnished with slender chevron bones which terminate in a hæmal spine. Neural spines slender and directed backwards; the caudal series somewhat resembling that of a fish. All the centra amphicœlian.

This genus differs from all those with enlarged and sculptured neural spines, and from those with abdominal scuta. It is equally distinct from those without ribs, abdominal rods, or limbs. It is possible that some of the species referred to *Tuditanus*, in which these parts are unknown, may belong to it, or that it may be established on a small species of *Leptophrac-*

tus, a genus only known as yet from cranial remains. With present knowledge the reference of the *I. ohiensis* to the latter genus is inadmissable. The cranium, thoracic region, and fore-limbs of *Ichthycanthus* are unknown.

Char. Specif. The centra of the dorsal vertebræ are about as long as deep, and their sides are deeply concave: there are four anterior to the pelvis which are without ribs. The caudal vertebræ are robust, and seven from the first, support a small tubercule-like diapophysis. The chevron bones are short and acuminate; the neural spines are a little shorter, narrow and truncate, and directed backwards at the same angle as the chevron bones. They are much reduced on the eighteenth caudal vertebra, where the chevron bones are considerably longer.

The abdominal rods are quite slender. The hind limb is quite stout for this order. The femur is regularly expanded at both extremities, but the distal is deeply and openly grooved, distinguishing the condyles, while the proximal end is plane. There is no trochanter visible. The ulna and radius are well separated, and are three-fifths the length of the femur. There is a large *fibulare* tarsal bone of a subquadrate outline. In immediate contact with it is the probably external digit with five phalanges or segments; the ungual is simply conic. The femur is as long as five dorsal vertebræ. The ribs have expanded, undivided heads, and extend to the abdominal armature.

Measurements.	M.
Length of last ten dorsal vertebræ	.047
" " first twenty-three caudal vertebræ	.117
" " a posterior rib	.029
" " " dorsal vertebra	.005
" " twenty-second caudal vertebra	.005
" " femur	.025
Proximal diameter of femur	.008
Width of lower leg	.009
Length of fibula	.015
" " tarsal bone	.006
" " digit	.027

This salamander is about the size of the *Menopoma allegheniense.*

Ichthycanthus platypus. Sp. nov.

This batrachian is represented by almost the same portions of the skeleton as the preceding species, furnishing a good basis of comparison. It is very well preserved, displaying the characters especially of the hind foot, which is almost entirely represented.

Several features distinguish it from the *I. ohiensis*, one of which is of more than usual value if correctly indicated by the fossil. There are ten vertebræ from anterior to the sacrum preserved in place, and none of them supports a rib, nor are there any ribs visible anywhere on the block of shale. I suspect that they exist on more anterior vertebræ, or may have been displaced to a more anterior position than they normally occupy.

The abdominal chevrons are more anterior in position than are those of the *I. ohiensis*. The hind legs are longer than in that species; in this one the femur equals seven and a-half vertebral centra in length. The external digit on the other hand, while bearing five phalanges, is distinctly shorter. The fibular tarsal is of a transverse oval, not quadrate, form.

The dorsal centra are short and deeper than long; the neural arches are elevated, with short but distinct zygapophyses, and a flat subquadrate, superiorly truncate neural spine. They bear short, vertically compressed diapophyses near the bases of the arches. The neural spines of the caudal vertebræ become rapidly more slender, and also diminish in length, while the zygapophyses are continued to the fifteenth vertebra, where the series is broken off. The chevron bones are slender, and enclose a moderate hæmal arch.

The femur is gradually expanded to the extremities. Proximally there is a trochanteric ala besides the obtuse head. Distally the condyles are well distinguished, the external or fibular being truncate. The fibula is less than three-fifths the length of the femur, and is expanded at both extremities. Two proximal tarsals are distinct; the one next the fibula is larger than the other and transverse suboval in form. It has a median dividing ridge as though composed of the *fibulare* and *intermedium* coössified. The *tibiale* is subtriangular. There are five distinct phalangeal tarsals. The toes are in the order of their lengths beginning with the shortest, 1—2—5—3—4. Their phalanges (including metatarsals) are, in the proper order, commencing with the hallux, 3—3—4—? 5—5; the distal end of the fourth finger being lost. These bones are rather stout, and the ungulas are simply conic. The form of the foot is short and wide. The number of phalanges is nearly similar to that I have found in the *Amphibamus grandiceps*, excepting that in that species the fifth digit has but four. They are more numerous on most of the digits in *Sauropleura digitata*.

Measurements.	M.
Length of ten dorsal vertebræ	.045
" " fifteen caudal "	.055
" " the centrum of a dorsal	.0038
Total elevation of a posterior dorsal	.014
" of posterior of zygapophysis of dorsal	.010
Length of femur	.032
Diameter of femur medially	.0045
" " " distally	.0083
Length of fibula	.018
Diameter of fibula proximally	.007
Width of sole at second row of tarsal bones	.017
Length of foot to end of third digit	.031
" " first digit	.010
" " third "	.022
" " fifth "	.020

LEPTOPHRACTUS LINEOLATUS. Sp. nov.

This large batrachian is represented by the middle portion of a cranium, including parts of both jaws with numerous teeth. It is not easy to determine which of the tooth-bearing bones preserved is maxillary and which dentary, but the lighter and thinner of the two is presumably the latter, although it has the greatest vertical depth. The opposing bone supports two types of teeth, and as this is only the case in the maxillary of *Leptophractus obsoletus*, the present bone may be provisionally referred to that position,

There is a great difference in the sizes of the two types of maxillary teeth, the larger having nearly three times the linear dimensions of the latter. The small ones are rather distantly placed, being separated by interspaces nearly equal to their lengths. They are cylindric at the base, but become compressed, and have two opposite cutting edges on the apical third. They are of rather slender form, and are striate at the base. The longer teeth have a similar form, but are less strongly compressed distally, where there are two opposite cutting edges. The basal portion is quite closely striate. These teeth are on a different basal line from the small ones, since when their bases are removed the latter appear behind them. Three smaller teeth stand in the spaces between two large ones.

The mandibular teeth are intermediate in size between the large and small ones of the maxillary series, having a little more than half the linear dimensions of the former. Their terminal three-fifths are compressed, and furnished with fore and aft cutting edges.

The surface of the bone, where visible, does not display the punctate sculpture of that of the *L. obsoletus*, but is nearly smooth, displaying only fine parallel incised striæ.

Measurements.	M.
Depth of dentary bone at middle	.030
Length of mandibular tooth	.009
Antero-posterior diameter of mandibular tooth at base	.0035
Length of long maxillary tooth	.022
Antero-posterior diameter do. at base	.006
Length of small maxillary tooth	.007
Antero-posterior diameter do. at base	.002

The smaller size and slender form of the smaller maxillary teeth, as well as the peculiar sculpture distinguish this species from the *L. obsoletus*.

Another specimen of *Leptophractus* resembles the one above described in the form and disposition of the teeth, and has the osseous surface of both maxillary and dentary bones marked with shallow grooves and punctate impressions which do not inosculate. In this it resembles the maxillary bone of the large specimen figured on Plate XXXVII of the second volume of Paleontology of the Report of the Geological Survey of the State of Ohio.

Tuditanus tabulatus, Sp. nov.

This species is indicated by a specimen which includes a cranium, and the anterior part of the vertebral column. It is very well preserved on a block of shale, on both faces, and exhibits the constituent pieces of the cranium, the vertebræ, one of the thoracic shields with probable ribs. In all respects it conforms to the genus *Tuditanus* in characters ; presenting a broad, flat head ; osseous vertebræ and ribs ; thoracic shields present, and abdominal chevrons probably absent. The last character is not absolutely assured, since the posterior two-thirds of the vertebral columns are wanting.

The cranium is wider than long, and the muzzle is broadly rounded. The orbits are wide ovals, and their posterior borders fall little behind the transverse line dividing the skull equally. The interorbital width equals the longitudinal diameter of the orbit. The posterior outline of the cranium is truncate in a straight, transverse line between the prominent epiotic angles. The distal extremities of the quadrates do not project so far backwards as the epiotic angles, and are still further removed from a transverse line marking the extremities of the occipital condyles. In this respect this species presents a strong contrast to the *Pelion lyellii,* where the ends of the quadrates extend posterior to the latter points. The composition of the superior cranial walls much resembles that of the *Tuditanus radiatus.* The epiotics are large bones, longer than wide, and present outwards strong angles, which correspond with the horns of *Ceraterpeton.* They enclose between them the posterior portion of the parietal, and the supra-occipital. The latter is a transverse bone, and not quite symmetrical in the specimen, one end having a greater antero-posterior extent than the other. The parietal is the largest cranial bone, is undivided, and is pierced by a median foramen behind the centre. Its general form is broadly wedge-shaped, the lateral borders expanding in front of the fontanelle, and contracting between the epiotics. The frontals are distinct and rather narrow. The post-frontals are rather large, are in close connection with the parietal on one side and the jugal on the other, and send a point backwards between the epiotic and supratemporal. The jugal widens fan-shaped backwards, joining two bones distally, a superior and an inferior. The former is the supra-temporal, but whether the inferior is quadratojugal or squamosal, I cannot determine. The boundaries of the bones of the extremity of the muzzle are not distinct.

The sculpture of the surface of the cranium consists of parallel ridges which are separated by grooves equal to them in width. The ridges radiate inwards on the epiotics and frontals, and outwards on the squamosal, and are transverse and interrupted on the supraoccipital. The lateral thoracic shield is covered with a similar sculpture of uninterrupted somewhat radiating ridges. The vertebræ are osseous, and rather small compared with the size of the skull. Opposite to the posterior extremity of the pectoral shields is a pair of slender bones, which are gently expanded and truncate at the extremities. It is not certain whether these belong to the

forearm, or are a pair of short ribs. Impressions only of the teeth remain; they indicate small pleurodont denticles like those of the *Anura*.

Measurements.	M.
Length of cranium above	.029
Width " "	.037
" between epiotic angles	.018
" of interorbital space	.007
" " orbit	.006
Length " "	.007
" " skull to fontanelle	.008
" " from orbit to nares	.005
" " " " " to end of snout	.003
" " lateral pectoral shield	.015
" " atlas	.004
Width " "	.004

This species of *Tuditanus* differs from the *T. radiatus* in the larger and less anteriorly placed orbits, and in the large truncate posterior table of the skull. The proportions of the latter are more those of *P. obtusus*, but the epiotic angles have not been observed in this species, the sculpture is punctate not linear, and the form of the supraoccipital is quite different. Comparison with the other species referred to that genus is unnecessary, excepting in the case of the *T. mordax*. Further examination of the specimen on which the latter was founded leads to the belief that it is an imperfect cranium of *Ceraterpeton punctolineatum* Cope. The latter name, as the preferable one, may be adopted, and the former becomes a synonym.

Colosteus scutellatus, Newberry; Cope, Rept. Geol. Surv. Ohio, Paleontology Vol. II, p. 407.

Another specimen of this species was obtained by Prof. Newberry during the past season, which includes some parts of the skeleton not previously observed.

The specimen presents a superior view of the ventral and thoracic protective armature, and of the posterior portion of the cranium. As heretofore, I find no indications of vertebræ, but along one side of the ventral scutellation, a series of slender ribs lies in the matrix. These I have not previously found in this genus. The cranial surface is only preserved on the lateral portions. Its sculpture consists of coarse grooves closely placed, directed outwards and forwards.

On a Dinosaurian from the Trias of Utah.

By E. D. Cope.

(*Read before the American Philosophical Society, February* 16*th*, 1877.)

Dystrophæus, Cope.

This genus reposes on scanty remains, but which are in good preservation, and which present marked characters. The bones consist of the humerus, three metatarsals, some ? tarsals, and the distal end of an ? ulna, with a probable sternum and an inferior element of either the scapular or pelvic arch, probably the latter. There is also a number of fragments, which are not easily identified. The specimens were discovered by Prof. J. S. Newberry in South-eastern Utah, while acting as Geologist to the Engineer Exploring Expedition under the command of Captain McComb, United States Army, He excavated them from the red and green rocks usually referred to the Trias, hence from the same formation which yielded the *Typothorax* already described. Professor Newberry made sketches of the bones as he exposed them. They were all, he states, found in close proximity, the bones of the limb in nearly normal relation. It is altogether probable, according to Professor Newberry, that they belong to a single animal. I find nothing to forbid this supposition and much to confirm it.

One of the most remarkable bones is a broad, flat element, one of whose borders is digitate, the processes being long, and separated by deeply entrant sinuses. Two sides of the bone are broken away, but the others give origin to five digitiform processes. Two of these are larger and longer than the others, and externally on the right side is a shorter one. Outside of this is a larger process whose extremity is recurved so as to be subparallel with the longer processes, and which was connected with another bone by an articular surface. This information is derived from Prof. Newberry's notes made in the field. It is probable that this bone is the sternum, and that the articulation mentioned is costal. It is not certain whether the longitudinal meridian line passes through a sinus or a digitation, but a projection of the surface of the plate, which is probably median, is opposite one of the latter. Supposing then that the sternum is produced into a median posterior process, we find a resemblance to the corresponding element in many birds not heretofore known among reptiles. There are in that case three postero-externally directed processes on each side, of which the two posterior are free. Another interpretation might be that it is a coracoid with anterior digitations. In this case the articulation above mentioned would be anomalous. The number of digitations is too great for this element, and the space remaining for contact with the sternum is too small.

Another large flat bone approximates a right-angled triangle in form; the length greatly exceeding the width. The right-angle is massive and

produced, and is evidently the point of connection with the other parts of the skeleton. The bone is flat on one side and convex on the other, and can only be identified with probability, with the scapula of a Dinosaurian reptile.

The large size of the anterior limb, which might be inferred from this scapula, is justified by the humerus, which is preserved in almost perfect condition. This humerus is one of the longest, and is distally the most contracted known in the *Dinosauria;* the proximal extremity is of the form usual in that order. A short distance below the head, the section is T-shaped, with one end of the transverse limb shorter than the other. The ridge of which this limb is a section, is almost wanting at the head, which is thus Γ-shaped. The limb representing the stem of the T is stouter than the others, and forms the summit of a massive column, which soon sinks into the shaft. Its free extremity is obtuse and rounded, and though representing the head, does not rise above the level of the other crests, or tuberosities. The distal extremity of the humerus looks much like that of a tibia. It is truncate, and its long axis is in the plane of the tuberosities of the head. Its outline is oval, one end narrowed to an angle, and the other broadly rounded. The surface is roughened with coarse pits.

The distal extremity of another long bone, most probably the ulna, is more robust than that of the humerus. The shaft is a flattened oval, and the articular extremity is a wide and somewhat irregular oval, the greatest transverse diameter being nearer one end. The articular surface is roughened with coarse pits.

Three metatarsals were found in immediate proximity to each other, two in nearly their normal relations, and one slipped forwards. They are neither remarkable for length nor abbreviation. The proximal ends are truncate, and the distal ones convex, but without distinct median grooves or lateral angles. Both extremities are moderately expanded, and the shafts are contracted at the middle. The external bone is a little shorter than the two others, and is more flattened. It has a slightly-defined convex head, with an adjacent prominent, but ill-defined, lateral crest. The larger of the longer bones has a crest at one angle, like that of an olecranon process. The proximal end of the same bone is massive, and is trapezoidal in outline; the outline of the corresponding head of the adjacent bone is triangular. A marked character of these bones is the rough or pitted surface of their articular extremities, except the distal end of the shorter bone. The shafts are solid, and filled with nearly equal, coarse cancelli.

The bones above described are evidently those of a Dinosaurian reptile, and they present characters which have not been previously observed in any other genus of the order. The form of the condyles of the humerus distinguishes it from the other known genera, especially from those of the European Trias, where the crest is weak or wanting.

The rugose articular surfaces are also peculiar, indicating less than the usual mutual movement of the bones upon each other. A cartilaginous cap is indicated, which was probably the element from which the mam-

malian epiphysis was derived. The sculpture of the surfaces is coarser than that to which epiphyses are attached in the *Mammalia*. The name of the genus expresses this character.

It is altogether probable that this genus embraced terrestrial animals, with powerful fore- and hind-limbs subequally developed. The typical species is of gigantic proportions.

Dystrophæus viæmalæ, Cope.

In the supposed sternum of this animal (which I have not seen, but which was sketched by Professor Newberry), a rather small, slender and compressed process projects from near the middle of one of the sides at right angles to it. Only two of the lateral processes are represented as complete. The longer is subspatulate; the shorter subacuminate. The scapula presents three complete borders,—the proximal and two lateral; but the distal is not known. Without it, the length is two and one-half times the breadth. The point of junction of the longer (and perfect) short border with one of the long borders, is much thickened, terminating in a mass of bone which is unfortunately broken, but whose section in the line of the end border is a wide oval. From this point, the plate thins away to the various borders. The greatest thickness is nearer the border which terminates in the enlargement described. This surface is then gently convex in transverse section, while the opposite one is concave to a less degree. It is thicker at the middle than at the anterior border in a longitudinal direction.

The proximal extremity of the humerus is much expanded. The greater tuberosity is a huge crest, as prominent as the head, and separated from it by a marked concavity which constricts the mass connecting it with the head, thus forming a neck. This concavity extends about one-third the length of the shaft. On the opposite side of the head a similar concavity excavates the shaft, separating the internal from the interior ridge. The latter is in its middle portion as prominent as the external ridge, and extends as far downwards. The extensive external face of this part of the bone is nearly flat.

The internal ridge descending from the head, continues into the posterior border of the interior face of the shaft. The great tuberosity continues into the single external ridge of the shaft, which is thus near the middle triangular in section, the base of the triangle internal. The external extremity of the distal end is therefore an angle, and the internal a convex side, shorter than the anterior and posterior sides. A ligamentous groove marks the posterior border of the extremity at a point measuring one-third of its length from the external angle. The expanse of the distal extremity is not more than three-fourths that of the proximal. The entire bone so resembles a tibia, as to have induced me to refer it at first to that element. The characters of the proximal end are such as to render such identification highly improbable. Such reference would also require that the distal extremity should have a fore and aft direction, an arrangement incompatible with the tibia.

The displaced metacarpal is flattened, and expanded at the extremities. One side is nearly flat, but slightly concave in the longitudinal direction; the other side is convex and nearly level in the longitudinal direction. The lateral borders of the shaft are thus narrowed. The distal end displays a convex condyle, and a flat, prominent ala, which is in the general plane. The ala is separated from the condyle by a deep groove on the convex side. The condyle is a half-hemisphere only, presenting only with the convex side of the shaft, from which it is not separated by a constriction. It is bounded at its distal edge by an angle, which is a continuation of the proximal edge of the ala. The proximal extremity is injured at one angle, but, with this complete, would be nearly a regular rhomboid with parallel longer and shorter outlines; the acute angle of the latter being the continuation of the lateral border of the shaft. The extremity is subtruncate, and part of the surface is irregularly excavated by pits and grooves. The transverse extent of the proximal end, when perfect, was probably a little greater than that of the distal.

The two adjacent metacarpals are subequal in length, and longer than the displaced one by one-fourth the length of the latter. One of these bones is throughout rather thicker than the other, although the transverse diameter of the shafts is equal; but the stouter bone is considerably more dilated at the extremities. The distal end of the stouter bone is thickened in the direction at right angles to the plane of the limb; but the chief expansion is in that plane. The angle next to the other bone is protuberant, while the other angle is expanded into a sharp, convex crest, or ala. A section of this extremity is diamond-shaped, with one of the lateral planes produced into this crest, while the corresponding border of the opposite side drops down, being represented by a mere convexity of the surface which continues to the crest. The surface of the extremity is irregular. The section of the shaft is a broad oval, becoming subcircular near the proximal extremity. The latter is enlarged in both directions. It is a rectangle in outline, a little extended in the plane of the limb, with one of the angles cut off from the corresponding angle to the middle of one side. The long side thus left is slightly convex, and ends in an angle. The side subtended by this angle is slightly concave, and is approximated to the other bone. The opposite side is slightly emarginate near the middle. Its surface is very slightly convex, and is irregularly grooved and pitted.

The more slender of the two bones is but little and about equally expanded at the opposite extremities. The distal end would have an ovoid section, but for the fact that it is obliquely truncate at the extremity next to the other bone. It is convex in the antero-posterior direction and plane in the transverse; its surface is grooved and pitted. The side next to the other bone is flat or slightly concave at the distal end, and, though thicker than the external border, becomes rounded at the middle of the shaft, and is again flattened at the proximal extremity. The external border is distally produced into an obtuse angle; lower down, the shaft has a thin, angular border. The proximal end has less antero-posterior diameter than

the distal, and is subtriangular in outline; the apex being acute and external. The surface is flat, and is strongly marked with deep grooves. The other surfaces of the limb-bones are smooth, except a few weak ridges near the distal ends of the two distal bones.

Measurements.		M.
Length of part of scapula preserved		0.680
Width at middle		0.270
Thickness at middle		0.048
Thickness at proximal angle		0.117
Total length of humerus		0.765
Diameter of proximal end	at head	0.080
	at tuberosities	0.225
Diameter of shaft	antero-posterior	0.080
	transverse	0.078
Diameter of distal end	antero posterior	0.085
	transverse	0.145
Transverse diameter of head of humerus		0.160
Diameter of extremity of ? ulna	antero-posterior	0.110
	transverse	0.150
Length of external metacarpal		0.210
Proximal diameter	antero-posterior	0.045
	transverse	0.100
Diameter of shaft	antero-posterior	0.033
	transverse	0.067
Diameter distally	antero-posterior	0.050
	transverse	0.115
Length of median metacarpal (stouter)		0.245
Diameter proximally	antero-posterior	0.057
	transverse	0.115
Diameter of shaft (transverse)		0.055
Diameter distally	antero-posterior	0.074
	transverse	0.088
Length of median metacarpal (slender)		0.240
Diameter of proximal end	antero-posterior	0.057
	transverse	0.089
Diameter of shaft (transverse)		0.049
Diameter distally	antero-posterior	0.041
	transverse	0.083

More than usual interest attaches to this fossil. It is the first one found in the Triassic beds of the Rocky Mountain region, and was derived from an inhospitable region rarely traversed by white men. The locality is in the Painted Canyon not far from the Sierra Abajo in South-eastern Utah, near the Colorado boundary; lat. 38° 15′; lon. 110°. This canyon is one of those tributary to the Great Colorado River, and is without water. The rock is described by Prof. Newberry as the same as that which I

have identified in New Mexico as the Trias, and is of the usual red color. The occurrence of a terrestial Dinosaurian at that locality tends to confirm the conclusion to which I have already attained, that this immensely extended deposit is of lacustrine character.

On a New Proboscidian.

By E. D. Cope.

(*Read before the American Philosophical Society, March* 2, 1877.)

I recently received from a correspondent in one of the Southern States, a fossil of unusual interest. It is a molar tooth of a proboscidian, whose color and mineral character indicate that it was derived from beds of the Upper Miocene or Loup Fork epoch. Its roots are largely broken away, while the crown is nearly perfect.

The crown consists chiefly of two transverse crests, which are separated by a deep uninterrupted valley. There is no general cingulum. Each crest is divided into three lobes, which are not deeply separated, but cause the edge of the crest to be serrate with three conic eminences. Of these the median apex has a rounder section, while the lateral are more transverse, rising at the external borders like the extremities of the crests in *Mastodon ohioticus.* The appearance of the base of the crown at one extremity indicates that it was in contact with the preceding tooth. The opposite extremity of the base presents no such surface, and hence points to the conclusion that the tooth is the last one of the series. From the middle cone of the anterior crest a cingulum descends on each side, passing round the anterior base of the external cones. It is wanting at the extremity of the base of one of these, and little developed on the other, but they reappear on the side of the base bounding the valley. They are crenately tubercular, except at the base of the median anterior tubercle. There is no cingulum at the base of the posterior crest, except the ordinary filling between the bases of the lobes. One of the extremities of the crests is a little higher than the other, and the basis is a little wider than at the other end ; it is therefore probably external in position. At the posterior base of this end is a fractured surface indicating a cingular tubercle of stout proportions, such as is more in place at the external posterior angle of the last superior molar than in any other tooth.

The external cone is defined from the median by a fissure, while a better defined depression separates the median from the internal. This depression is filled by a worn tubercle in the anterior crest. Ridges descend along the adjacent borders of the constituent cones nearly to the fundus of the valley, and the bases of the external ones are considerably wrinkled.

Measurements.	M.
Transverse diameter of crown	.130
Longitudinal " " internal	.070
" " " external	.090

Elevation of external cusp	.065
" internal "	.055
Length between apices of external cusps	.043

The molar tooth described exceeds in transverse dimensions that of the *Mastodon ohioticus*, and evidently belonged to one of the most colossal of land animals. Its generic position is near to *Mastodon* and *Dinotherium*, but if the tooth on which my observations are based be complete, it is distinct from either. The possession of only two transverse crests separates it from the former, and would, were the tooth an anterior molar, refer it to the latter. As it appears to be a posterior molar, this view of its affinity becomes untenable, and I therefore establish for it a new genus, under the name CÆNOBASILEUS. The tooth described resembles that of the genus *Tapirus*, but differs in the absence of the external trihedral enlargement of the cross crests seen in the superior molars of the former, and also in the tubercular and fissured character of the crests proper. The species may be called *C. tremontigerus*.

The typical specimen was probably obtained in Texas, but I am not yet informed as to the precise locality.

ISSUED MARCH 19, 1877.

PALEONTOLOGICAL BULLETIN, No. 25.

Verbal communication on a New Locality of the Green River Shales containing Fishes, Insects and Plants in a good state of preservation.

By E. D. Cope.

Owing to the rather softer character of the matrix the characters of the fishes could be worked out with much nicety. A collection which he had recently received includes sixteen species, all new. Their names are as follows:

? Chromididæ.
Priscacara serrata Cope.
" *cypha* Cope.
" *liops* Cope.
Percidæ.
Mioplosus abbreviatus Cope.
" *labracoides* Cope
" *longus* Cope.
" *beanii* Cope.
Asineopidæ.
Asineops pauciradiatus Cope.
? Aphredodiridæ.
Erismatopterus endlichii Cope.
Amphiplaga brachyptera Cope.
Clupeidæ.
Diplomystus dentatus Cope.
" *analis* Cope.
" *pectorosus* Cope.
" *humilis* Leidy.
" *altus* Leidy.
Osteoglossidæ.
Dapedoglossus testis Cope.
" *? encaustus* Cope.

Of the above genera all but two are new to science, and all of the species but three are likewise new. From the present collection something like a general view of the ichthyological fauna could be obtained, since the predominant types were probably represented in it. *Priscacara* is a Pharyngognath allied to the *Chromididæ* and *Pomacentridæ*, most nearly to the former; and *Dapedoglossus* is not far removed from *Arapæma* and *Osteoglossum*. The facies of the fauna is of a mixed character, both fresh water and marine types being present. The largest species is the *Osteoglossum encaustum;* the second in size the *Diplomystus dentatus*, which exceeds the moss bunker (*Brevurtia menhaden*).

The descriptions of the species and genera are in process of publication in the Bulletin of the U. S. Geol. Survey Terrs.

On a New Species of Adocidæ from the Tertiary of Georgia.

By E. D. Cope.

Professor George Little, State Geologist of Georgia, placed in my hands for determination a Chelonite from a Tertiary formation in Macon Co. of that State. The matrix is a rather soft limestone of a light drab color. When the specimen was first obtained it was nearly perfect, lacking only the posterior part of one side, and the posterior border of the carapace. Having been mutilated by destructive curiosity hunters, there remain now the plastron and the anterior half of the carapace, with a considerable portion of the posterior part of the left margin. The surface has been exposed to the weather so as to obscure, and in some places to obliterate the dermal sutures, while the skeletal sutures are distinct. The form has been slightly distorted by lateral pressure, but not much.

The obscurity of the dermal sutures renders the determination of the generic affinities somewhat difficult. The skeleton preserves the Emydoid type, not exhibiting intersternal bones, and having a well developed mesosternum. The vertebral bones extend to between the sixth pair of costals, beyond which the specimen is imperfect in that region. The costal capitula are well developed, but whether they reach the vertebral centra, the specimen does not permit me to discover. The plastron is of peculiar form, the lobes being short and contracted. The anterior is rounded from a base of usual width, while the posterior, from a similar base, narrows rapidly to a point, as in the genus *Aromochelys*.

An important point is observed in the direction of the abdomino-pectoral dermal suture. At its lateral extremities instead of continuing to the marginal scuta as in Emydoid genera, it turns forward and terminates at the inguinal notch, as in genera with intermarginal plates, as *Adocus* and *Dermatemys*. But the sutures of the intermarginals in the specimen are, if they ever existed, very obscure, owing to exposure to the weather. Nevertheless there is sufficient indication of them on one side, to render it tolerably safe to infer their existence. Anterior to the abdomino-pectoral suture, the border of the plastron is crossed by emarginations representing three scutal sutures, defining the humeral, gular, and intergular scuta. The courses of these sutures across the plastron are obscure. The humero-pectoral suture commences on the margin just in front of the axilla and extends forwards parallel with the border, becoming a deep open groove, which is apparent on both sides of the plastron. It then turns backwards, and appears to cross the plastron behind the mesosternum, presenting a concavity forwards. The next suture in front appears to cross near the middle of the mesosternal bone, presenting a strong concavity forwards. The relation between the intergulars and the gulars is difficult to discover. The suture between them at the free margin is distinct, but after proceeding inwards a short distance it appears to divide and take two directions. One

depressed line extends backwards to the humero-gular suture, cutting off triangular gulars and extending the intergulars back to the humerals as in *Adocus*. The other depression extends directly across the anterior lobe, cutting off small intergulars as in *Baëna*. In either case the arrangement represents a genus distinct from either of those named. If the intergulars extend to the humerals they are double, the mesosternal region being divided by a distinct longitudinal dermal suture. If the intergulars are short, with the gulars in contact behind them, the arrangement is equally distinct from *Adocus*. From *Baëna* the absence of intersternal bones, and the Emydoid mesosternum distinguish it. It approaches also *Polythorax*,* and may indeed belong to that genus. But it does not appear that the humerals and interhumerals are distinct in the Georgia turtle, and no intermarginals are observed in *Polythorax*. It is therefore necessary to give the present genus a name to be used until its relations to the latter are positively ascertained. I propose AMPHIEMYS for the genus, and A. OXYSTERNUM as the specific name.

Specific characters. The plastron is nearly plane in the transverse direction ; longitudinally the posterior lobe is a little raised above the plane, and the anterior lobe rather more so.

The general form is elevated, the vertical diameter being large when compared with the longitudinal and transvere, which preserve usual proportions. The border of the carapace is not flared at the sides, and rises anteriorly to the nuchal bone. The free anterior margin is somewhat undulate. The anterior half of the carapace does not display any median or lateral keels.

The nuchal bone is considerably wider than long, and the costal and marginal sutures are of about equal length. The vertebrals are all longer than wide, and of the usual form, with truncate antero-lateral angles, excepting the first. This one has both the sides and extremities convex, the latter being of subequal width. The costals are thick, and have parallel borders. The marginals are all higher than long, especially those of the bridge.

The sutures of the plastron are fine and straight. The portion of the mesosternum enclosed by the episternal or clavicular bones has greater longitudinal extent than the part embraced by the hyosternals. The sutures with the clavicular bone are nearly straight, and are parallel with the free border. The common suture of the hyosternals is a little longer than that of the hyposternals, and is a little shorter than that of the postabdominals. The anterior suture of the latter has a slight posterior obliquity, and is abruptly turned backwards at the free borders of the lobe.

The dermal sutures of the carapace are mostly obliterated. Enough remains to show that the second vertebral was wider than long, while the nuchal shield is considerably narrower than the nuchal bone. The marginal scuta are much narrower than the marginal bones, and become narrower forwards. The region of the nuchal marginal is obscure.

* Cope, Proceed. Acad. Philad'a, 1876, Nov.

Measurements.	M.
Length of carapace to the posterior border of seventh costal	.250
Depth at third vertebral bone	.150
Length of second vertebral bone	.031
Width " " " "	.032
Thickness " " "	.013
Length of first marginal "	.035
Width " " "	.033
Length of first do. of the bridge	.028
Width " " " "	.060
Width of second costal	.033
Thickness of " "	.012
Greatest width of carapace	.182
Length of plastron (axial)	.211
" " anterior lobe (axial)	.073
" " posterior lobe "	.070
Width of base of anterior lobe	.115
" " " posterior "	.086
Length of bridge	.090
" " mesosternum	.042
Width " "	.046
Length of clavicle	.051
" " common suture of clavicles	.014
" " " " " hyosternals	.051
" " " " " hyposternals	.047
Width of postabdominals at anterior border	.057

The shell of this species is thicker than in any species of tortoise now living in North America, a peculiarity characteristic of most of the species of the Cretaceous period, and of many of those of the Eocene. Its size is about that of the *Pseudemys serrata.*

On a Gigantic Saurian from the Dakota epoch of Colorado.

By E. D. Cope.

Not long since I was informed by the Superintendent of Public Schools of Fremont County, Colorado, Mr. O. W. Lucas, that he had discovered the bones of an enormous saurian at an outcrop of the rocks of the Dakota group, not far from Canyon City. I encouraged him to proceed with the exploration, and asked him to send some specimens which should explain the character of his discovery One of the first objects sent is a fragmentary lower jaw of a carnivorous dinosaurian, which he found on the surface of the ground. This fossil was found to belong to a species heretofore unknown, which I referred to the genus *Lælaps* under the name of *Lælaps trihedrodon.** The second sending included a number of vertebræ, which apparently represent a much more gigantic animal, and I believe the largest or most bulky animal capable of progression on land, of which we have any account.

The vertebræ comprise a cervical, three dorsal and four caudal vertebræ. The dimensions of the animal to which they belonged may be inferred from the fact that the first is twenty inches in length, and twelve in transverse diameter; and that one of the dorsals measures three and a half feet in the spread of its diapophyses, two and a half feet in elevation, and the centrum thirteen inches in transverse diameter. Another dorsal is two feet ten inches in elevation.

The centra of these vertebræ have a ball and socket articulation of the opisthocœlian type, the cups and balls being well pronounced. Just beneath the diapophysis is situated a huge foramen. A broken centrum from which Mr. Lucas removed the matrix, shows that this foramen communicates with a huge internal sinus, which occupies almost the entire half of the body of the vertebra. Those of opposite sides are separated by a septum which is thin medially. Thus the centra of the dorsals are hollow. The neural arches are remarkable for their great elevation, and the great expanse of the zygapophyses. They are more remarkable for the form of the neural spines, which are transverse to the long axis of the centrum. That of one of the vertebræ is strongly emarginate so as to be bifurcate. The widely extended diapophyses support the rib-articulations, and there are no capitular articular facets on the centra, but such are found on the basal region of the diapophyses in some vertebræ.

The supposed cervical vertebra is depressed, the anterior or convex extremity of the centrum the most so. It is remarkable for its elongate form exceeding the proportions found in known *Dinosauria* and *Crocodilia*, and resembling that seen in some fluviatile tortoises. Near the anterior extremity a short, robust parapophysis has its origin, from which it extends outwards and downwards, and soon terminates in a truncate extremity which presents downwards. A deep fossa occupies its upper base, and above

*Bullet. U. S. Geol. Surv. Terrs. III, 1877.

this a deep linear foramen extends throughout the greater part of the length of the centrum. If this vertebra possesses a diapophysis it is rudimental.

The caudal vertebræ are amphicœlian, but not deeply so. They are subquadrate in section and not so short as the corresponding ones of *Hadrosaurus*. The most anterior one of the series has short robust diapophyses, and is more concave anteriorly than posteriorly. The other caudals are more equally bi-concave, but the cavity is very shallow on the most distal of them. The centrum is also relatively more elongate and compressed than those of the others. None of them display the lateral pneumatic fossa which exists in the dorsals, and, where broken so as to permit a view of the internal structure, the latter appears to consist of rather finely spongy tissue. The chevron facets are not very well defined, and the neural spines are of usual forms, and on the anterior two vertebræ, elongate.

Several genera have been described which possess some of the features presented by the one to which the present animal belongs. The following are characterized by the presence of the lateral sinuses of the vertebral centra: *Megadactylus* Hitch., *Cetiosaurus* Owen., *Ornithopsis* Seeley, *Bothrospondylus* Ow., and *Pneumatosteus* Cope. The first of these may be dismissed with the remark that its caudal vertebræ possess the sinuses as well as the dorsals, which we have seen is not the case with the Colorado animal. The centra of *Cetiosaurus*, according to Owen, and those of *Pneumatosteus* do not exhibit the cavernous structure above described, but are uniformly spongy interiorly. *Ornithopsis*, of Seeley, which Owen refers to his subsequently described *Bothrospondylus*, possesses a cavernous cellular internal structure, which I have not found in the reptile from Canyon City, Colorado, but which occurs in another huge saurian discovered by Prof. Lakes near Golden, Colorado, in the same stratigraphical horizon. Another name (*Chondrosteosaurus*) has been introduced by Prof. Owen, but he specifies no generic characters; nor points out how it differs from *Ornithopsis*, which it resembles in its cellular structure.

Prior to the reception of the present specimen, I was negotiating with Prof. Arthur Lakes, of Golden, Colorado, for the acquisition of another fossil skeleton of a gigantic saurian which he had discovered in that region. This gentleman sent for my inspection two vertebral centra with other fragments. Anticipating their purchase I made some remarks on their characters before a meeting of the American Philosophical Society held on July 20th of the present year. Before my arrangements with Prof. Lakes were completed, the bones which he had found were purchased by Prof. O. C. Marsh, of Yale College. The specimens in my possession were thereupon sent to Prof. Marsh, and my proposed article withdrawn from the hands of the printer. A short time previous to this, a portion of a sacrum of a saurian found by Prof. Lakes had been noticed by Prof. Marsh in the July number of the *American Journal of Science and Arts*, and he had given names generic and specific to the animal to which it belongs. That of the genus not being accompanied by any specific diagnosis nor specific reference to its characters, has no claim to adoption according to

the rules of nomenclature, nor can the genus be distinguished from some of those above enumerated from the few characters of mixed significance which are mentioned. Especially is there nothing to indicate that it differs from *Ornithopsis* or *Bothrospondylus*.

The opportunity of studying the dorsal and caudal vertebræ of the saurian discovered by Professor Lakes, enables me to point out the characters in which the animal from Canyon City differs from it. The centrum of the dorsal vertebra from near Golden is concave posteriorly and plane anteriorly, instead of being convex anteriorly. The supposed caudal is larger than the dorsal vertebra, while that of my specimen is smaller than that of the dorsal centra. The articular faces are nearly plane, not bi-concave, and the antero-posterior diameter of the centrum is disproportionately small, as in *Hadrosaurus*. It has a lateral fossa, and its interior is cavernous. A detached neural spine of this saurian has a form not widely different from what is usual in these reptiles, and totally unlike the extraordinary shape of the present genus.

On such grounds I regard the present species as representing a genus hitherto unknown, which may be called *Camarasaurus* and the species :

Camarasaurus supremus.

Many peculiarities are exhibited by the vertebræ of this species, which are not described in saurians known up to the present time. Many of these would have been lost in less careful hands than those of Mr. Lucas, and science is much indebted to him for the preservation of many thin osseous walls and buttresses. In general, the external walls of the centra are thin, and the processes are composed of laminæ, united by narrow margins. The vertebræ are lighter in proportion to their bulk than in any air-breathing vertebrate.

The anterior extremity of the centrum of the cervical vertebra is prominently convex, and much depressed. The posterior and concave extremity is wider, and of rather greater vertical diameter. The base of the neural arch only occupies half of the length of the centrum, an equal extent of the superior surface extending freely beyond it at its anterior and posterior extremities.

The linear lateral foramen commences a little behind the anterior base of the neural arch, and descending somewhat in its direction, terminates beneath the posterior extremity of the base of the neural arch. The base of the latter overhangs the foramen and the base of the transverse process. The inferior surface of the centrum is concave, the concavity being bounded in front by the inferior convex thickening of the extremity. Behind the middle the surface becomes plane, and is, near the posterior extremity, bounded on each side by a short, angular ridge.

Measurements.	M.
Length of centrum between anterior convexity and posterior lip	.565
Depth of posterior cup	.090

		M.
Diameter of cup	vertical	.310
	transverse	.160
Length of parapophysis		.095
Width of neural canal		.063

The dorsal vertebra which I suppose to be the anterior one of those received is characterized by its undivided transverse neural spine. The entire neural arch is of enormous elevation, but as the zygapophyses are above its middle, the neural spine is not as long relatively as in various other genera, or as in the caudals of this one. The sides of the centrum are strongly concave, and the borders of the cup flaring. The neural arch is everywhere excavated, so as to reduce the bulk, and produce lightness so far as consistent with strength. The diapophyses rise from a point above the neural canal, and are directed upwards as well as outwards. It sends a narrow ridge down to the sides of the centrum, on each side of which its shaft and base are deeply excavated. The posterior of these fossæ is overlooked by the wide zygapophysis ; and the roof of the anterior one supports the anterior zygapophysis. The former are separated by another and vertical septum, which bifurcates below, forming two prominent borders of the neural canal. At each side of the base of the neural canal there are two trilateral fossæ, of which the anterior is much the larger, and extends higher up on the lateral edge of the spine. They are separated by a lamina. The diapophysis is not very long, and is subtriangular in section near the extremity. The neural spine is thickened at the extremity as though for the attachment of a huge ligament. At the summit of its posterior basal fossa, at the middle of its height, is an outwardly curved process with a smooth, extero-superior face.

Measurements.	M.
Length of centrum	.275
Total elevation of vertebra	.830
Elevation to posterior zygapophyses	.550
" of superior edge of diapophyses above centrum	.350
" of neural spine above posterior zygapophyses	.295
Length of diapophysis behind	.215
Depth of extremity of do. (restored)	.075
Transverse extent of summit of neural spine	.215
" " neural spine at middle	.330

Another dorsal vertebra is better preserved than the last described. It is distinguished by the lack of the median portion of the neural spine and the extension outwards, of the median lateral processes described above. The diapophyses are much larger, and the zygapophyses more extended transversely. The centrum is constricted at the middle, and especially just behind the convex articular extremity, whose circumference forms a prominent rim. The edges of the lip are flared outwards, forming a deep basin, much wider than deep. The fossæ described in the last vertebra

are present in this one, but differ in proportions, owing to the greater size and expanse of the superior parts of the neural arch. The fossa posterior to the base of the diapophysis is nearly plane, while that at the anterior base is deeply excavated, is narrower, and extends so far along the inferior side of the process as to give it a semi-circular section near the middle. Distally the diapophysis has a trialate section owing to its three longitudinal ridges, and the articular extremity is large and antero-posterior in direction. The process differs from that of the vertebra already described, in the possession of a facet near the middle of its anterior inferior bounding ridge, which is probably costal, as in the vertebræ of *Crocodilia*. The lateral foramen of the centrum is subround. The general surface is smooth.

Measurements.		M.
Total elevation of vertebra		.770
Total transverse extent of diapophyses		1.010
Diameter of centrum	longitudinal	.300
	vertical of cup	.250
	transverse "	.340
	" at middle	.205
Elevation of zygapophyses above centrum		.310
Diameter of zygapophysis	transverse	.170
	antero-posterior	.090
Width of neural canal		.085
Transverse extent of neural spine		.440
Length of diapophysis from posterior zygapophysis		.320
Antero-posterior width of end of diapophysis		.135
Diameter of centrum of anterior caudal	fore and aft	.170
	vertical	.245
	transverse	.245
Total elevation of do.		.545
Elevation of neural canal		.040
Antero-posterior width of neural spine		.075
Diameter of median caudal	fore and aft	.180
	vertical	.200
	transverse	.192
Diameter of posterior caudal	fore and aft	.155
	vertical	.175
	transverse	.145

Besides the characters above-mentioned under the head of the genus, in which the vertebræ of this species differ from those found by Professor Lakes, I may add that they also differ in general proportion. Those of the *Camarasaurus*, are relatively shorter and wider, and more depressed, with deeper cup, and less elongate lateral foramen or fossa. The proportions of the caudals differ totally. The dorsal vertebræ are larger than those of the Golden City saurian.

What the total dimensions of this saurian are, is not readily estimated

without further data. Six cervical vertebræ of the length of the one described would give a neck of ten feet in length. The femur, which I have not yet received, is stated by Mr. Lucas, to be six feet in length. I hope ere long to be able to give a fuller account of this remarkable creature, which exceeds in its proportions any other land animal hitherto discovered, including the one found near Golden City by Professor Lakes.

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PALEONTOLOGICAL BULLETIN.

NO. 26.

On some new or little known Reptiles and Fishes of the Cretaceous No. 3, of Kansas.

By E. D. Cope.

(*Read before the American Philosophical Society, August* 17, 1877.)

Toxochelys latiremis Cope.

Final Report U. S. Geol. Surv. Terrs. II. pp. 98, 299.

Two nearly complete crania of this species found by Mr. Sternberg, enable me to give the genus a definite position in the system.

The prefrontals have an extensive mutual contact, and extend to the external nares, where they are somewhat contracted by the superior processes of the maxillary. They descend to the vomer, and are extensively in contact with it. There are no distinct nasal bones. Lachrymal foramen rather small. The temporal fossa is extensively roofed, and the supraoccipital crest much produced backwards.

The posterior nares are rather anterior, and are separated, and not underroofed by the osseous vomer. This element expands in front of the nares, where it separates the maxillaries.

A foramen separates the maxillaries from the palatines, and the ectopterygoids expand laterally. The superior alveolar surface is wide, and slightly concave. The external border is elevated and acute, and the inner border is slightly prominent and is roughened.

The characters above adduced show that the genus *Toxochelys* is one of the *Cryptodira*, and that it is distinct from *Euclastes* (Cope) of the cretaceous No. 5. In that genus the posterior nares are underrun by a production of the vomer, and the alveolar faces of both jaws are much wider. The general form of the skull of *Toxochelys* is much like that of many *Trionychidæ*, but from these the characters of the marginal bones of the carapace, and the form of the extremities separate it.

Ichthyodectes goodeanus sp. nov.

This largest species of the genus is represented by a right premaxillary and a large part of the maxillary bones. The alveolar border is concave at the anterior part of the latter, and then becomes convex. The maxillary border is incurved at its anterior extremity, so that the line of teeth is turned inwards as well as strongly upwards, the middle part of the border being the most prominent. In this respect it differs from the other species, where the anterior part of the alveolar border is the most prominent. The anterior border is sigmoidally curved, and the vertical diameter is twice the transverse. The premaxillary teeth number thirteen and are somewhat compressed so as to have opposed cutting edges ; they are without grooves or ridges. The maxillary teeth are round in section. The posterior maxillary condyle is not protuberant, and is decurved anteriorly. The maxillary underlaps the premaxillary to near its anterior border.

Measurements.	M.
Depth of maxillary behind condyle	.047
" " at "	.053
" premaxillary	.069
Length " at middle	.037
Four functional maxillaries in	.020

This species is dedicated to my friend Prof. G. Brown Goode, of Middleton, Conn., collaborator of the Smithsonian Institution.

I may here state that another very distinct species of this genus is the *Ichthyodectes arcuatus* (*Portheus accuatus* Cope. 4to Report U. S. Geol. Surv. Terrs. II. p. 204). It is characterized by the attenuation of the bones of the face, and jaws, and the small size and large number of its teeth. Those of the maxillary bone are so small as to become obsolete on the posterior half in old individuals.

ICHTHYODECTES ACANTHICUS sp. nov.

The smallest species of the genus, distinguished by the attenuated and curved crowns of the teeth. It is represented in my collection by portions of the dentary, parasphenoid, and other bones. The teeth on the anterior part of the dentary bone are nearly round in section, and their enamel is smooth. The crowns are curved inwards towards the apices, which are slender and acute. The anterior tooth is on the extremity of the dentary.[1] The lateral processes of the parasphenoid are wide and flat, and are pierced at the base by the usual two foramina. The interorbital portion of the bone is concave in the section of its inferior surface.

Measurements.	M.
Length of the crown of a tooth	.005
Diameter " " "	.001
Five mandibular teeth in	.012
Width of parasphenoid at middle	.006
Depth of parasphenoid at middle	.004

This species and the last described were obtained by my assistant, Chas. H. Sternberg, from the chalk of the Cretaceous No. 3 of Kansas.

ORICARDINUS TORTUS gen. et sp. nov.

Char. gen. Teeth inserted in shallow aveoli, with the roots more or less exposed; on the posterior half of the maxillary bone unequally so, so as to be pleurodont. The anterior part of the maxillary bone depressed, with superior articular facet, and united with the premaxillary by a ginglymus.

This genus is apparently nearly allied to *Pachyrhizodus* as I have defined it. In that genus the anterior maxillary teeth are strongly pleurodont, and the maxillo-premaxillary suture is squamosal. To *Oricardinus* must probably be referred the *P. sheareri* m.

Char. specif. This is derived from a right maxillary bone and a num-

ber of vertebræ, supposed to belong to the same individual by my assistant, Russell Hill, who discovered it.

The proximal extremity of the maxillary bone is depressed, both the external and internal aspects presenting prominent ribs. The inner rib soon disappears, and the alveolar border becomes interior in position, the teeth then assuming a more pleurodont character. The external rib continues, and rises so as to form the superior border of the jaw, but continues to have an oblique direction outwards. It is separated by a longitudinal concavity from the portion that bears the alveoli. The teeth are subcylindric in section, and the crowns are acute and incurved. The proximal end of the maxillary forms a condyle for transverse movement, which is divided by a transverse groove. Above this groove the extremity is fissured.

The vertebral centra are somewhat hour-glass shaped, and present a deep longitudinal fossa on each side of the base of each neural and hæmal arch, which is divided by a vertical rod on partition of bone, which strengthens the arch. The arrangement is that seen in the genus *Empo*, The sides of the centra are marked with rather regular linear grooves, which disappear at the contraction.

Measurements.		M.
Length of maxillary bone preserved		.066
Distal depth		.011
" width		.005
Proximal depth		.005
" width		.006
Eight teeth in		.020
Diameter of caudal centrum	longitudinal	.010
	transverse	.009
	vertical	.010
Diameter of anterior centrum	longitudinal	.009
	transverse	.011
	vertical	.009

In the *O. sheareri* the dental alveoli are transverse to the long axis of the maxillary bone, while here they are longitudinal or round; the bone is more laminiform in the *O. tortus*.

Anogmius favirostris sp. nov.

The characters of the genus *Anogmius* Cope having up to the present time rested upon but one species (*A. aratus*), it is satisfactory to be able to confirm them by the study of new material. This, which was obtained in Kansas by Mr. Sternberg, consists of the almost entire superior part of the skulls of two individuals, one of them with thirteen vertebræ.

The vertebræ, which undoubtedly belong to the skull, have no lateral grooves, but the superior and inferior pairs of fossæ are present. The inferior fossæ are separated by a plane interval on the anterior centra, which rapidly narrows posteriorly. The centra are not elongate nor

contracted at the middle, and are sculptured with fine longitudinal grooves.

The cranium is depressed, and was so in life. The form of the muzzle is the extremity of an oval, at the apex of which are the two short premaxillaries, while the sides are composed of the long maxillaries. The top of the head is nearly smooth, marked only posteriorly by a few delicate radiating grooves and dots.

The inferior view displays the vomer, palatine, and maxillary bones with their myriad teeth *en brosse.* Those of the maxillaries form a narrow band, those of the premaxillaries a little wider one. The palatines are long flat bones similar to those of the *Stratodus apicalis,* but of less elongate proportions, and the teeth they bear are relatively smaller and not in longitudinal rows as in that fish. The teeth of the median line of the palate form an elongate tongue-shaped patch, flat and acuminate in front, but gently convex, and with lateral bevels more posteriorly. The teeth it supports are very close together as on the palatine bones. The posterior portion of this patch is broken away. The mandibular ramus is not deep and the symphyseal surface is a rectangular truncation of the nearly parallel inferior and superior edges. The teeth are in many rows, the number diminishing posteriorly. The dentary is incurved to the symphysis. The premaxillary bone is not smooth like the others of the cranium, but is pitted anteriorly, and radiately ridged posteriorly.

Measurements.		M.
Length of cranium		.102
Width of cranium behind		.050
Length of premaxillary bone		.015
Depth of the dentary		.009
Length of palatine bone		.052
Width " " "		.010
" " vomerine dentate patch		.010
Diameter of a cervical vertebra	longitudinal	.005
	transverse	.009
	vertical	.007

ANOGMIUS EVOLUTUS Cope.

This fish is represented by an entire left mandibular ramus. As corresponding parts are preserved in the typical specimens of *A. aratus* and *A. favirostris,* comparison with these species is easy.

The ramus is less curved than in either of the species mentioned, indicating an elongate and wedge-shaped head. The symphysis is short ; deeper than wide, and but little incurved. The ramus is much contracted vertically at the glenoid cavity, which is deeply impressed and decurved on the inner side, having thus a convex transverse section. The angle is recurved behind the glenoid cavity, and also produced for a short distance in line with the inferior margin of the ramus, this portion being separated by a sinus from the superior process. The form of the angle is then that

of a boot with the toe elevated. The inferior edge of the inferior process is acute.

The inferior border of the ramus is thin. The superior border is thickened, and its tooth bearing surface descends on both the internal and external faces of the bone. Posteriorly, this face is presented inwards, but this tooth-band narrows forwards on this side, and widens on the external face. Its greatest width on the latter is posteriorly, an inch in front of the widest internal exposure; it then gradually contracts, its inferior border rising to a short distance behind the symphysis.

The dental alveoli are small and round, densely packed, and sub-equal in size. Near the middle of the ramus, thirty longitudinal rows may be counted. Not a tooth remains. A transverse section of the greater part of the length of the dentary is strongly convex; anteriorly it is flattened above.

Measurements.	M.
Length of ramus	.234
" " tooth band	.150
Depth of symphysis	.016
" at posterior end of tooth band	.050
" at glenoid cavity	.019
" at angle	.030

STRATODUS OXYPOGON Cope.

This fish is represented in Mr. Sternberg's collection by a dentary bone, a probable maxillary, and a portion of the palatine, both the latter without their extremities. A number of vertebræ accompany the jaws, which probably belong to the same individual.

The dentary is narrow and cuneiform, and rather robust for its depth. The tooth band is wide, covering more than half the vertical diameter of the bone, and is bounded below by a groove. The external face is convex. A delicate groove extends along the superior margin just below it; and a wide open groove commences behind the middle of the length and above the middle of the vertical diameter, opening widely behind. The inferior edge is compressed and flat, and is abruptly distinguished from the convex portion. The symphyseal surface is short, and the infero-anterior border is produced into an acute angle. The teeth are in six rows on the widest part of the band. Of these one contains larger teeth than the others; at one point it is the second from the external margin, but its position becomes more interior on the anterior part of the band. The teeth are recurved, round in section, and with simple, very acute apices. These are transparent and vitreous; the remaining portion of the tooth is opaque, and marked with whitish dots. At the anterior extremity of the dentary, but two rows of the smaller sized teeth remain.

The alveolar fossæ of the teeth of the three interior series of the dentary band, have a peculiar character. The internal half of the border has short radiating lines touching its circumference, but the external half supports

three convex lobes of dense tissue. The lateral of these are divergent and dorsal; the median is narrower, and is radial to the circumference. This structure does not appear in the alveolar fossæ of the three external rows. It is probably a hinge like attachment permitting elevation and depression of the teeth of the inner rows.

The supposed maxillary bone presents a wide open groove on both sides The superior border is convex in section and not so wide as the tooth bearing face, which is slightly oblique. But for this obliquity the section would be that of a T-rail. The groove of the internal face is continued further forward than that of the external face. There are six rows of teeth arranged as in the dentary bone, but in reversed order.

The fragment of palatine bone is densely packed with teeth, which are longer than those of the jaws. Their apices are as in the latter, simple. Those of one border are longer than those of the other, and the alveolar fossæ of these (the only ones I can see) bear the three adjacent tuberosities above described.

The vertebræ considerably resemble those of *Empo*. Their centra in both abdominal and caudal regions are elongate and contracted medially. There is a shallow longitudinal groove at the bases of the neural and hæmal arches, which are divided vertically by a median rib-like buttress. The median lateral portion is smooth or nearly so.

Measurements		M.
Length of dentary bone preserved		.0550
Depth " " " at middle		.0080
" " dentary tooth band at middle		.0050
" " " at symphysis		.0045
Length of maxillary bone preserved		.0530
" " " tooth		.0045
Depth " " at middle		.0060
Width " " " "		.0050
" " palatine bone		.0100
Diameter of an abdominal vertebra	longitudinal	.0160
	transverse	.0115
	vertical	.0125

This species differs from the *S. apicalis* in the simple form of the apices of the teeth. The type specimen is much smaller than that of *S. apicalis*.

Descriptions of Extinct Vertebrata from the Permian and Triassic Formations of the United States.

By E. D. Cope.

(*Meeting of the American Philosophical Society, November 2d,* 1877.)

The Triassic formation of North America has yielded many of the reptilian types which characterize the horizon in other parts of the world. A Labyrinthodont has been recognized in North Carolina, and I have determined the existence of the genus *Belodon* in the formation in both that State and Pennsylvania. Of *Dinosauria* three types occur in both Europe and North America. The *Palæosaurus* of the former country is represented by the American *Clepsysaurus,* and *Zanclodon* is somewhat similar in dental characters to the *Zatomus* of North Carolina. Of genera with compressed teeth which have a lenticular section, and both edges denticulate, *Bathygnathus* has been found in North America, and *Cladiodon* and *Teratosaurus* in Europe. This type has, however, been wanting heretofore from the extinct Triassic fauna of Pennsylvania and North Carolina. The present communication introduces it for the first time from the former State, under a form generically different from any of the preceding, and with the name

Palæoctonus appalachianus.

The specimens on which this determination rests, were found by my friend Charles M. Wheatley, A. M., in one of his copper pyrites mines. The most characteristic are two teeth which differ somewhat from each other in form. One of them has a greater transverse, and less anteroposterior diameter, indicating an anterior position in the series. The other is more compressed, and presents a greater anteroposterior width. Judging by the analogy of the genus *Lælaps,* this tooth occupied a position posterior to the first one. The two were found in close proximity, though not in actual contact, in a fragile, argillaceous portion of the copper-bearing rock.

The profile of the anterior tooth is regularly conic with a slight recurvature, which is not seen in the apex, but in the basal portion of the crown, and in the root. The section is almost semicircular at all points, but the inner and flatter face is slightly convex ; rather strongly so at the apex. The denticulation of the edges is minute, measuring M. .00033. It continues to the base of the crown both fore and aft. At this point the edges are as elsewhere, at one side of the anterior and posterior aspects. There are no ridges nor facets on the crown, and the enamel possesses an obsolete minute rugosity of short linear ridges.

The crown of the second tooth is not only flatter and wider than that of the first, but is little more than half as long. Both edges are crenate to the base. The marked peculiarity of the tooth is seen in the division of the crown into facets by angular ridges. The convex face is divided into two, an anterior-looking and a posterior-looking, the former half as wide

as the latter. The angle separating them is not continued on the apical third of the crown. The section of the antero-external face is nearly plane. The division of the interior or flatter face is similar, but the angle is less pronounced. The anterior and narrower face is slightly concave. In this crown, as in the first described, there are weak transverse undulations near the basal third.

Measurements.		M.
Length of anterior tooth preserved		.080
Length of crown of same		.055
Diameter of base of crown	antero-posterior	.022
	transverse	.016
Diameter near apex of same	antero-posterior	.010
	transverse	.008
Length of posterior tooth preserved		.040
Length of crown of second tooth		.029
Antero-posterior diameter at base of crown		.025
" " at middle of crown		.019
Transverse diameter " " "		.010

These dimensions indicate an animal of the general proportions of the gigantic carnivorous *Dinosauria* of the genera *Lælaps, Megalosaurus* and *Teratosaurus*. They exceed those of the *Bathygnathus borealis* and the only known species of *Cladiodon, C. lloydii.*

The characters which demonstrate that this Saurian belongs to a genus distinct from any of the above are, Firstly, the presence of the external and internal longitudinal ridges which divide the crown of the posterior tooth into four facets. Second, the shortness of the crown as compared with its width, a point in which it approaches *Palæosaurus*. Thirdly, the semicircular section of the anterior tooth, a form not found in either *Bathygnathus* or *Teratosaurus*, where almost the entire series is known. It is only approximated in some of the Western species referred to *Lælaps*, but is not inconsistent with the characters of that genus as represented by them.

To the genus thus characterized, the name *Palæoctonus* is given, and to the species, the name *Palæoctonus appalachianus.*

Associated with the teeth of this species, were found several leaves resembling those of *Pterophyllum;* and stems of *Calamites* occur in the same locality.

Additional specimens received from Mr. Wheatley include anterior, intermediate and posterior teeth of a larger animal than the one above described, and intermediate and posterior teeth of a much smaller individual of probably the same species.

The large half-conical tooth of the large individual, presents a slight groove-like constriction at the basal portion of the posterior cutting edge. Length of crown above base .060 ; width at base .025. Width of posterior tooth at base .030. The form of the intermediate tooth is between those of the others. Its external face is very convex and is not faceted. The

approach of the external face to the anterior or cutting edge is much more abrupt than to the posterior.

The teeth of the smaller saurian only differ from the others in their size. The more posterior is probably anterior in position to those described above, as its external face is more convex, especially anteriorly, and is not faceted. Length of crown of the anterior tooth .032; width at base .019. Width of base of posterior tooth .015; length .019.

PALÆOCTONUS AULACODUS, sp. nov.

The teeth of this saurian differ from those of the *P. appalachianus* in having their basal portion sculptured with parallel shallow grooves. These are quite close together, leaving ridges between them which are narrower than themselves. The surface of the crown displays the silky sculpture of minute raised lines more distinctly than in the other species. But one tooth of this animal has been so far obtained by Mr. Wheatly, and this one is from the middle of the series of an animal rather smaller than the second individual of the *P. appalachianus*. In accordance with this position the crown is short and half conic with the external face strongly convex, most so in front. The denticles are well exhibited on both edges, but only descend on the anterior to the middle of the length of the crown. In both large and small specimens of P. *appalachianus* the denticles descend nearly or quite to the base. Length of crown .022; width at base .011.

CLEPSYSAURUS VEATLEIANUS, sp. nov.

Represented by a single large tooth in perfect preservation. In accordance with the characters of the type species, *C. pennsylvanicus* of Lea, the tooth is straight, and possesses two cutting edges. The posterior of these is denticulate and perfectly straight; the other is less extensive and is separated from the posterior by very unequal surfaces.

In the present saurian the tooth is compressed, and rounded in front, the section throughout the basal half being an oval with one end acute. The antero-interior edge only exists on the apical half of the crown, and is separated from the posterior edge by a somewhat convex face two-thirds the width of the external face. It is not denticulated, and its lower extremity falls behind the anterior margin of the crown when viewed in profile. The enamel is perfectly smooth. Length of crown from base of enamel layer .047; longitudinal diameter at base .018; transverse do. 011.

As compared with the *C. pennsylvanicus* of which several teeth are known, the *C. veatleianus* differs in its more compressed form, and in having the anterior cutting edge not denticulated. The position of this edge is more internal than in the longer known species, but this may indicate a more anterior position in the jaw.

This saurian is named in compliment to Charles M. Wheatley, A.M., of Phœnixville, Pa., to whose exertions we owe nearly all the material hitherto obtained from the Triassic formation of Pennsylvania.

SUCHOPRION CYPHODON, gen. et sp. nov

Char. gen. As no portion of the animals referred to this genus is known, other than teeth, the characters are derived from these only. Their crowns are elongate, conical and curved, and are furnished with denticulate cutting edges. In the teeth preserved these are separated by very unequal extents of surface, as they form the anterior and posterior borders of the inner face. The crown is penetrated by a very minute pulp cavity, and it consists of a number of distinct concentric cones.

It is probable that teeth have been discovered in Europe which belong to saurians of this genus, but I cannot find that they have ever received a distinctive name. They resemble those of *Crocodilia* rather than *Dinosauria*.

Char. specif. The only species of *Suchoprion* as yet known to me is represented by four teeth found in the same beds and formation as those above described. One of these is of large size, indicating that it reached the adult dimensions of the Gangetic gharrial. They display some difference in the degree of convexity of the external surface, which is sometimes opposite the imaginary plane of the inner face, sometimes oblique to it. The degree of convexity is always greatest at the base of the crown. The inner face is also convex. The curvature in the long direction is not great, and is directed to the inner side. The surface presents a minute silky sculpture ; one tooth presents a very few shallow sulci.

Measurements.

		M
Diameter of largest tooth	antero-posterior...........	.021
	transverse.................	.020
Length of crown of tooth No. 2	....	.045
Diameter crown tooth 2	antero-posterior............	.009
	transverse..................	.016

BELODON CAROLINENSIS, Emmons.

Cope, Trans. Amer. Philos. Soc. 1869, p. 59.

Teeth of the anterior portions of the jaws were obtained by Mr. Wheatley.

BELODON PRISCUS, Cope.

Trans. Amer. Philos. Soc. 1869, p. 59.

Teeth from the anterior part of the jaws. In addition to the six species of saurians above noted, Mr. Wheatley obtained the tooth of a Stegocephalous Batrachian, probably a Labyrinthodont.

CRICOTUS GIBSONII, Cope, sp. nov.

While examinations into the Clepsydrops shale of Eastern Illinois have revealed a great abundance of individuals, and three species of *Clepsydrops*, the genus *Cricotus* has remained without addition, and the three vertebræ hitherto found, appear to belong to but one species, the *C. heteroclitus*. The present notice describes a second form, represented, like the first, by but few

remains. The vertebra which is best preserved, and which may be regarded as typical, is probably from the caudal series, and is thus well contrasted with the corresponding typical vertebra of the longer known species.

On this vertebra there is no trace of diapophysis, and the neurapophysis rises from the external side of the superior face. The wall of the neural canal is not preserved, but the inference is that the diameter of the latter is large. This fact and the absence of definite chevron articulations leads me to doubt the caudal position of the vertebra ; but the usual marks of the dorsal and cervical vertebræ are totally wanting from it. As in *C. heteroclitus*, the *foramen chordæ dorsalis* is large, its diameter being one-third of the total. The articular faces descend steeply into it, that of one extremity more so than the other. The rim of the latter face is beveled outwards, the plane thus produced appearing on the inferior face something like the united faces of the chevron bones.

The centrum is a little deeper than wide, and the inferior face is truncate so as to give a subquadrate outline. The inferior plane is concave, the concavity being divided by a longitudinal rib. The sides are somewhat concave, with a longitudinal rib at the middle. Diameters of centrum : vertical .010 ; transverse .009 ; longitudinal .008. Width of inferior plane .005 ; width above, including neurapophyses, .008.

As compared with *C. heteroclitus* this species differs in the presence of parallel ridges enclosing a median fossa on the inferior side of the centrum. The small size may be here considered, but it is uncertain whether the two animals represented by the vertebræ are fully grown.

This reptile is named in recognition of the services of William Gibson of Newport, Ia., who has added a number of interesting facts to the geology of the Wabash region.

Cricotus discophorus, Cope, sp. nov.

A vertebra, representing an animal as large as the *C. heteroclitus*, presents characters so much at variance with those of the latter as to require special notice. Three other vertebræ of smaller size present similar features.

The centrum is disciform, with very short antero-posterior diameter, which is, however, greater at one part of the surface than at the opposite point. The foramen chordæ dorsalis occupies about one-fifth of the transverse diameter, which is subequal in all directions. The articular faces of the centrum are slightly concave. The margin of that of one side is beveled for the superior two-thirds of the circumference, the bevel running out below by turning into the articular face. The latero-inferior border of the latter turns out into an obtuse angle at this point. The superior part of the bevel runs into the lateral face of the centrum. The attachment of the neural arch is obscure or wanting in the specimen, and the same is true of any facet for chevron bones.

Diameter of articular face	vertical	.025
	transverse	.025
Length of centrum below		.009
" " above		.007

Another vertebra of nearly the same character, and one-half smaller size, presents a greater difference between the long diameters of the upper and lower sides. The superior diameter is only one-half the inferior, and the foramen chordæ dorsalis much nearer the superior than the inferior margin. Its diameter is one-fourth the vertical and one-third the transverse diameter.

From the same locality and discoverer as the *C. gibsonii.*

LYSOROPHUS TRICARINATUS, Cope, gen. et sp. nov.

Char. gen. Vertebræ amphicœlian, perforated by the foramen chordæ dorsalis. Neural arch freely articulated to the centrum. Floor of neural canal deeply excavated. No processes nor costal articulations on the centrum, which is excavated by longitudinal fossæ. Centrum not shortened.

This genus resembles in the proportions of the centrum, the genus *Clepsydrops*, but differs in many details.

Char. specif. Two centra and a portion of a third represent this species. The former are a little longer than wide and a little depressed. The facet for the neural arch is an elongate plane truncating the border of the fossa of the neural canal on each side, for one-half to three-fifths the length of the centrum. Two deep longitudinal fossæ extend on each side of a median rib of the inferior face ; and they are separated above by a narrower rib from another longitudinal fossa which is below the base of the neural arch.

Measurements.		M.
Diameter of centrum	longitudinal	.0055
	vertical	.0038
	transverse	.0040
Length of facet for neurapophysis		.0035
Width of neural canal		.0020

Discovered by Wm. Gurley, near Danville, Illinois.

DIPLOCAULUS SALAMANDROIDES, gen. et sp. nov.

Char. gen. Vertebral centra elongate, contracted medially, and perforated by the foramen chordæ dorsalis ; coössified with the neural arch, and supporting transverse processes. Two rib articulations one below the other, generally both at the extremities of processes, but the inferior sometimes sessile. No neural spine nor diapophysis ; the zygapophyses normal and well developed.

The vertebræ of this genus much more nearly resemble those of a salamander than any hitherto found in this formation, but it will be necessary to observe the cranium before this point can be determined.

Char. specif. One of Dr. Winslow's and two of Mr. Gurley's sendings contain vertebræ of this species. One from the latter gentleman is contained in a mass of clay in immediate contact with a mandibular ramus which supports a number of teeth. The ramus appears rather too

large for the animal to which the vertebra pertained, but the proportion is not different from that which I describe below in the genus *Eryops*.

The surface of the centrum is smooth and is without grooves. The diapophyses and parapoyhyses are rather elongate, and are closely approximated one above the other. The superior process issues from the centrum opposite the superior margin of the articular faces. They stand equidistant from the extremities of the centrum, and are directed obliquely backwards. The anterior zygapophyses occupy the same level. The neural spine is a compressed longitudinal ridge ; it divides behind, leaving a notch between the posterior zygapophyses.

Measurements.		M
Diameter of centrum	longitudinal	.0060
	vertical	.0025
	transverse	.0025
Depth of centrum and neural arch		.0060
Width with transverse processes		.0070
Expanse of posterior zygapophyses		.0050

The mandibular ramus which accompanied one of the vertebræ is shallow and stout. Its external surface is sculptured with sharp longitudinal ridges, which inosculate more or less. The teeth have cylindric roots which occupy shallow alveoli sunk in a plane surface. The crowns are rather elongate and compressed near the apex, and without grooves or serræ. In contact with the jaw is an osseous fragment with a pitted or reticulated surface.

Depth of ramus	.0030
Length of crown of tooth	.0023
Four teeth in	.0040

ERYOPS MEGACEPHALUS Cope gen. et. sp. nov.

Char. gen. The details of the structure of this genus are derived from an almost entire cranium with underjaw, which is accompanied by numerous vertebræ and other bones. The form is Labyrinthodont, and embraces the largest species of that group yet known from this continent.

The skull is not elongate, and the quadrate bones are produced far backwards. The epiotic processes are present but not remarkably elongate. The temporal fossa is covered in by the usual roof. The orbits are round, posterior in position, and small. There is no postorbital depression or groove, and the lateral epiotic sinus is not deep. The nostrils are large and widely separated. There is no angular process of the mandible. The maxillary teeth are of different sizes, although arranged in a single row. The posterior are small and not closely placed ; large teeth appear anterior to the middle. The premaxillary bone supports a number of large teeth. Those of the mandible which are visible in the specimen in its present state, those opposite the nares, are of medium size. The form of the crowns of the teeth is conic, with weak fore and aft cutting edges. There

are no distinct fissures of the surface although these may be represented by some fine parallel lines.

Vertebræ referred to this genus are small in proportion to the dimensions of the skull. They are not discoidal but somewhat elongate; are biconcave, and are not perforated for the notochord. The middle portion of the centrum is contracted. One articular extremity has the borders of the concave centre, convex. Zygapophyses large. Ribs present short; neural spines elongate, stout.

In comparing this genus with those described by authors and arranged by Mr. Miall in his family *Euglypta*, its exclusion from the latter is evident in view of the absence of angular process of the mandible, and the nondiscoidal vertebræ. Its posteriorly placed orbits distinguish it from the genera of his second family, the *Brachyopina*, excepting perhaps *Rhinosaurus*. It is with the genera of the third family, the *Chauliodonta*, that affinity appears to exist. It is unnecessary to compare *Eryops* with *Loxomma*, which has immense and irregularly shaped orbital openings, and trenchant teeth; but with *Zygosaurus* and *Melosaurus* the affinity is closer. The deep postorbital depressions, and the grooved maxillary teeth, described by Eichwald in the former genus, separate it at once. The teeth of *Melosaurus* are equally distinct, being, according to Meyer, conical and deeply grooved at the base. In *Rhinosaurus* the maxillary and mandibular teeth are said to be sub-equal. *Leptophractus* has deeply grooved teeth with strong cutting edges.

Char. specif.—In this category I include many of those introduced into the generic diagnosis by Mr. Miall in the very useful report to the British Assoc. for the Advancement of Science, 1874, p. 149, by the Committee on the Structure and Classification of the Labyrinthodonts. Such are the width of the interorbital space, the outline of the muzzle, the details of the sculpture, the approximate number of the teeth, etc.

The cranium has a sub-triangular outline, with the sides a little longer than the base, and the apex (muzzle) very obtuse. The profile is elevated behind, and the sides slope steeply to the mandible; the slope of the muzzle is rather steep, but less so than that of the cheeks. The extremity of the snout is broadly rounded and depressed, and overhangs the mandible. The supra-occipital outline is concave, and the epiotic angles only moderately prominent. . The quadrate bones extend far posteriorly, and are horizontal above at their distal extremities. The orbits are nearly round, although somewhat wider than long, and they are directed equally outwards and upwards. The inner margin is slightly flared upwards, and it terminates anteriorly and posteriorly in a slight tuberosity, at the junction with the canthus rostralis and temporal ridge respectively.

The orbit occupies the anterior portion of the posterior third of the length of the skull, including the epiotic angles; and its long diameter is one-seventh that of the skull from the epiotics to the muzzle inclusive. The same diameter is about half of the interorbital width. The parietal region is plane, the frontal gently concave, and the muzzle depressed convex

in cross-section. The face in front of the orbit is concave below the canthus rostralis. The nostrils are not large, and are sub-round. They are widely separated, being nearer the maxillary border at its junction with that of the premaxillary, than to the median line. The mandible is shallow, and not very stout. Its inferior border rises from below a point a little in front of the fundus of the epiotic sinus to the angle, which is at the quadrate articulation. Symphysis short.

The sculpture of the anterior portions of the muzzle is coarsely punctate ; on the posterior portions of the upper and lower jaws it is ridged and pitted. Most of the upper surface of the skull is still covered with a thin layer of the matrix, so that the sculpture and the character of the lyra, if any there be, remains unknown.

The teeth, as has been observed, are not visibly grooved, but the characteristic feature of the group may be represented by numerous delicate crack-like lines which one sees on the basal portions. These, however, look like the result of weathering. The sections of all the teeth would be round, but for the cutting edges, which are not very prominent. In addition, the premaxillary teeth are coarsely fluted on the median half of their length. The fluting is not visible on an antero-lateral mandibular tooth, nor on a posterior maxillary tooth. The microscopic structure of the teeth is not yet investigated.

The bodies of the vertebræ have concave sides, and a sub-round section. Their neural spines terminate in an obtuse enlargement. Many of the characters of the vertebral column are yet concealed in the matrix. The distal portions of the ribs are straight, cylindric, and become stouter at the extremity.

Measurements.	M.
Length of cranium from the extremity of the os quadratum	.433
Length of cranium on middle line	.335
Length from end of muzzle to nostril	.073
Width of cranium between quadrates	.306
" " " epiotics	.118
" " " orbits	.086
" " at orbits	.294
" " between nares	.085
Diameter of orbits { antero-posterior	.048
Diameter of orbits { transverse	.057
Length of premaxillary tooth	.025
Diameter " "	.007
Length of posterior maxillary tooth	.010
Diameter of median " "	.007
Length of a dorsal centrum	.024
Vertical diameter of do.	.025
Elevation of neural spine of do.	.050
Length of rib on curve	.080

This interesting fossil was found in the Triassic formation of Texas by my friend Jacob Boll. The cranium and vertebræ were discovered in such relation as render it evident that they were parts of one animal.

STRIGILINA GURLEIANA, Cope, sp. nov.

This species is known by a single jaw or tooth in complete preservation, which was found, like the type of the genus *S. linguæformis** near Danville, Ill., by Mr. Gurley.

The tooth is quite small, its length only equaling the width of the known tooth of *S. linguæformis*. It is also narrower in proportion to the length. The root and the cutting edge are turned in opposite directions as in the other species. The principal difference between the two is seen in the character of the transverse ridges or crests of the oval face. There are two crests less, or five, with a delicate basal fold, making six, while, counting the fold there are eight in *S. linguæformis*. The anterior ridge is transverse; the others slightly convex backwards, and all are equidistant and uninterrupted, which is not the case in the older species. They are also of different form, being distinct ridges with anterior and posterior faces similar. In *S. linguæformis* the anterior face only is vertical, the posterior descending very gradually, the whole forming a series of steps. Length of ridged face .0060; width anteriorly .0035; width posteriorly .0020.

This species is dedicated to William Gurley, of Danville, Illinois, to whose zeal science is indebted for the species from that locality described in this and other papers.

Twenty species have now been obtained from the Clepsydrops shales, the exact geological position of which remains to be accurately determined. Dr. Winslow informed me that they are the bed No. 15 of Prof. Bradley's section of the Carboniferous rocks of Vermilion county, Illinois. This places them near the summit of the Carboniferous series, below two thin beds of coal (which word is misprinted "coral" in my last paper, Proceed. Amer. Philos. Soc. 1877, p. 63). I am now informed that this portion of Prof. Bradley's scale is not correct, and that No. 15 occupies a much higher position than he assigns to it. It lies unconformably above the merom sandstone of Mr. Collett, which deposit is above the coal measures and unconformable to them. The stratigraphical evidence is thus conformatory of that derived from paleontology, that the *Clepsydrops* shale occupies a position in the scale above the coal measures.

CTENODUS PUSILLUS, Cope, sp. nov.

Form narrow, the width of the base about equal to the depth. The coronal portion is narrower than the base, because the inner face is oblique, forming an acute angle with the inferior plane. There are but four crests, of which the two longer are directed in one direction, and the two shorter in another. The interior ones of both pairs form a continuous

*Proceedings Amer. Philos. Soc. 1877, p. 52.

crest which is convex inwards. The crests are straight, elevated and acute ; each one supports two or three denticles, which are rectangular and little elevated. The longer ones project beyond the general outline ; the shorter ones are less prominent at the extremities; all are obtuse in the vertical direction. The superior surface is smooth. The inferior is slightly concave in the transverse sense. The tooth on which this species is found is the smallest yet obtained from the formation. Length, .007 ; width, .003 ; depth at inner crest, .003.

Two specimens were found by Wm. Gurley, in Vermilion Co., Illinois, in the *Clepsydrops* shale.

I have referred two species from this formation to the genus *Ceratodus*, under the names of *C. vinslovii* and *C. paucicristatus*. While the form of these teeth is that of the genus named, the structure of the superficial layer differs in wanting the punctæ which are characteristic of *Ceratodus*, but is, on the contrary, uniformly dense, although frequently irregular. I therefore refer the two species above mentioned to another and allied genus, under the name *Ptyonodus*, with *C. vinslovii* as type.

ORTHACANTHUS QUADRISERIATUS, Cope, sp. nov.

Represented by an incomplete radial spine. With it occur several fragmentary spines which resemble very closely one belonging to *O. gracilis*, Newb. (Geolog. Survey of Ohio, Pl. lxix, fig. 7), and which only differ in having the denticles shorter. As teeth of a *Diplodus* near to or identical with *D. compressus* are common in the shale, the two may belong to the same fish. Dr. Newberry has already suggested that *Orthacanthus* and *Diplodus* are identical.

The *O. quadriseriatus* is quite different from the other species. The spine is wider than deep, and the series of denticles are widely separated. The surface between them is gently convex and smooth. The anterior face is strongly convex and presents at each side two shallow furrows. The external groove is divided by a series of thin longitudinal denticles which are smaller than those of the principal row, and which are sometimes somewhat confluent at the base. The principle denticles are closely placed, stout, acute, and recurved. Transverse diameter of shaft .0035 ; antero-posterior diameter .0025. The portion of the shaft preserved is straight.

ARCHÆOBELUS VELLICATUS, gen. et sp. nov.

"Species No. 4," Cope, Proceed. Amer. Philos. Soc. 1877, p. 55.

Several other specimens of the body described as above have been obtained by Messrs Winslow and Gurley. In every instance it is a tooth-like process attached to a solid base by anchylosis in the manner of the teeth of fishes. From the appearance it presents I am led to suppose that it is the only one of its series, and there are none of the numerous teeth of the collections which can be associated with it. I therefore distinguish the genus by a name and the following diagnosis.

The form is conical, and the surface is not grooved nor furnished with

prominent ridges. The interior is hollow, and the walls are composed of a few concentric layers without external enamel or cementum. The solid base to which it is attached is shallow, presenting smooth surface on the opposite side, which is deeply impressed by a longitudinal groove at one end.

The characters of this species are pointed out at the place above quoted. The measurements of a large specimen are : length .015 ; diameter of base, long .008 ; short .005.

I am not sure as to the part of the skeleton to which this body should be referred.

On Reptilian remains from the Dakota Beds of Colorado.

By E. D. Cope.

(*Meeting of American Philosophical Society, November* 2, 1877.)

Since the discovery of the huge saurian *Camarasaurus supremus* (Cope, Paleontological Bulletin, No. 25, p. 5), Superintendent Lucas has explored the horizon of the Dakota of the Eastern Rocky Mountains near the Arkansas River for other indications of extinct life. His search has been rewarded by the finding of several species of reptiles of interesting character, which it is the object of the present paper to describe.

Caulodon diversidens gen. et. sp. nov.

This large saurian is represented by ten teeth found together, but separated from the cranial bones, and in a more or less broken condition. I select four of these exhibiting the characters most clearly.

Char. gen. Fang of the tooth of great length and hollow, and contracted at the base. It is without excavation for successional tooth. Crowns of the teeth of different forms in different portions of the jaw ; the posterior are like the bowl of a spoon ; others have a similar form but are more compressed, having double lateral ridges, while the crown of another, supposed to be an incisor, is little wider than the root, and has the section an oval with one side less convex than the other. All are coated with an enamel-like layer of considerable thickness which extends on the fang in some of the teeth. None of the crowns present cutting edges.

The characters presented by these teeth are quite distinct from anything hitherto found in North American Saurians. The absence of indication of the successional teeth is remarkable, and in connection with the contraction of the base of the root, suggests that the mode of succession of teeth approximated that exhibited by the *Mammalia.*

Char. specif.—The roots of all the teeth are cylindric. The crown of the posterior tooth is convex on one (the external) side, and concave on the other. The convexity is increased by a contraction of the external surface near and parallel to each border. The concavity is divided by a longitudinal rib which disappears at the base. This edge of the

crown is obtuse, as is also the apex. The outline of the apex is rather broadly acuminate. The enamel is closely and strongly rugose, longitudinally on the base, transversely at the edges, and reticulately on the middle portions of the crown.

Measurements.		M.
Length of crown with portion of root		0.120
Diameter of root at middle		.025
Length of crown		.055
Diameter of crown	longitudinal	.030
	transverse	.020

The crown of the second tooth is a little less expanded laterally, and has a greater transverse diameter. The outer side is more convex, and there are two marginal ribs on the basal half of the crown. The interior are not strictly marginal, but are situated within the exterior ribs. Both are very obtuse, and they are separated by a shallow groove. There is no median longitudinal rib.

Measurements.		M.
Diameter of crown at middle	antero-posterior	.026
	transverse	.018

The third type is smaller in all its dimensions, and the crown is equal to the root in long diameter. In my single specimen the distal portion of the crown is lost; the part which remains exhibits neither contraction nor expansion of outline. The borders are very obtuse, and each surface resembles a roll inwards which is bounded by a shallow parallel groove on the inner face of the tooth. Between the grooves the surface is slightly convex. The section is thus an oval with one side very little convex. The enamel is thick and marked with longitudinal rugosities.

Measurements.		M.
Length of fragment		.060
" " root		.030
Diameter "		.014
Diameter of crown at middle	longitudinal	.0135
	transverse	.0085

TICHOSTEUS LUCASANUS, gen. et sp. nov.

Char. gen.—The characters of this genus are derived primarily from the vertebræ. They are nearly amphiplatyan, but one extremity of the articular face is slightly concave, while the other is still more slightly convex or concave. The borders of the former are expanded, while those of the latter are not enlarged. The centrum is hollow, but the chamber does not communicate with the external median by a lateral foramen, as in *Camarasaurus.* The neural arch is attached by suture. There is no capitular articulation on the centrum.

Char. specif.—There is no hypapophysis on either dorsal or lumbar ver-

tebræ preserved, and the surface is smooth excepting some delicate longitudinal ridges extending to the border of the expanded extremity. The narrower extremity of a dorsal vertebra is nearly round and presents a slight median tuberosity ; the opposite end is wider than deep, and its surface is uniform. The smaller extremity of a lumbar vertebra is slightly concave.

Measurements.		M.
Diameter of dorsal centrum	longitudinal	.023
	vertical	.020
	transverse	.025
Width of base of neural arch with diapophysis........		.010

This species is dedicated to its discoverer, O. W. Lucas, of Canyon City, Colorado, the Superintendent of the Public Schools of the surrounding region. Through the scientific interest and energy of this gentleman the extinct vertebrata of the Dakota division of the Cretaceous Period hitherto unknown to science are being brought to light. The care and skill exercised by Mr. Lucas in the preservation of remains, which are often bulky, and always fragile, deserve the thanks of all students of this department of science.

Compsemys plicatulus, sp. nov.

Although tortoises have been discovered in older formations in Europe, the present species is the earliest yet obtained in North America. Its characters appear to coincide in important respects with those of the Lignitic formation which I have referred to *Compsemys* Leidy. This name I have proposed to retain for tortoises with marginal bones completely united with solid plastron, and the usual dermal scuta, and which differ from *Emys* in their Trionyx-like sculpture.

The *C. plicatulus* is represented by portions of both carapace and plastron of several individuals. While the distal extremities of the costal bones display the suture for the marginals, they also possess an inferior true costal prolongation, as in Trionyx. The proximal part is not preserved in any marginal bone, but the adjacent portions were united by fine suture. The proximal extremity of the costals exhibit the usual two directions, the shorter being posterior, and relating to the anterior part of the succeeding vertebral bone. The sternal sutures are fine ; that between the hyo- and hyposternal bone is transvere ; while that between the latter and the post-abdominal is oblique, and at the margin quite squamosal. At that point the hyosternal underlaps the post-abdominal for a considerable distance, and the suture of the inferior side of the plastron, after bending forwards, is abruptly recurved, running along the edge of the posterior lobe.

The scutal sutures are not wide nor deeply impressed, but the abdomino-femoral, and the femoro-anal are distinct. The median, longitudinal, sternal, and the costo-marginal sutures are irregular and serpentine. The sculpture is rather fine, and consists of rather closely placed tubercles and ridges. The borders of the elements of both carapace and plastron are marked

with ridges at right angles to the sutures, which are not short. The middle parts of the costal bones are marked by short interrupted or inosculating vermicular ridges closely placed. On the middle portions of the sternal bones the ridges are in places more broken, forming tubercles.

The surface of the bridge is angularly oblique to that of the plastron. The buttresses are not produced inwards. The free marginal bones are rather thin, and are not recurved.

Measurements.	M.
Length of a costal bone	.110
Width of the same	.032
Thickness "	.005
Length of hyposternal bone	.066
Width of the same at inguinal notch	.048
Thickness of the same in front	.007

Found by Superintendent Lucas with the foregoing species.

Clepsydrops limbatus sp. nov.

The discovery of a species of the genus *Clepsydrops* in Texas, in a formation hitherto regarded as Triassic, adds weight to the view above expressed, that the *Clepsydrops* shales of Illinois belong either to the Triassic or Permian formations. As typical of the new species I select a vertebra, which may be exactly compared with corresponding one of *C. collettii*. The centrum is about as wide as long, and its sides are very concave, much more so than in *C. collettii*, and the rim-like borders of the articular extremities are connected by a straight compressed hypopophysial keel. The sides of the foramen chordæ dorsalis are convex in the longitudinal section, thus contracting the opening, as compared with the very wide flare of the border of one of the extremities of the centrum. This flare receives the wide recurved border of the opposite extremity of the adjoining centrum, forming a kind of ball and socket articulation. This reflected surface forms a ridge with the funnel of the foramen at this extremity of the vertebra. The concave extremity is produced downwards, so that the foramen is considerably above the middle point. The diapophysis and parapophysis are not distinct nor elongate, but are represented by a projecting scar on the superior part of the centrum, which is directed downwards and forwards towards the rim of the articular face.

Besides the great contraction of the centrum, its relatively shorter form distinguishes it from that of *C. collettii*. It is also much larger than that species and the *C. pedunculatus*, being the largest of the genus.

Measurements.		M.
Length of centrum		.031
Diameter of centrum	vertical	.039
	transverse	.033
Width of neural canal		.006

Discovered by Jacob Boll.

Printed November 21st, 1877.

PALEONTOLOGICAL BULLETIN,

NO. 27.

On Amphicœlias, a genus of Saurians from the Dakota epoch of Colorado.

By E. D. Cope.

The genus to which the above name is now given, is allied to *Camarasaurus*, of which, and the gigantic species *C. supremus*, I have given an account in my Paleontological Bulletin, No. 25. Both genera differ from their nearest ally *Ornithopsis* Seeley, in the excavation of the vertebral centra, so as to include large chambers separated by a septum, which communicate with the external median by a lateral foramen. In the *Ornithopsis* it is stated that the vertebral centra are occupied by a number of coarse cells. In the more remotely allied *Cetiosaurus*, Owen has observed that the tissue of the centra is coarsely spongy.

The vertebræ from all parts of the column of *Camarasaurus* are known, and those of the dorsal and lumbar regions present the extraordinary character, of which a trace is seen in *Cetiosaurus*, of neural spines expanded transversely to the axis of the column. Numerous vetebræ of *Amphicœlias* are known, and in the dorsals in which the neural spine is preserved, the latter displays the usual form, that is, it is compressed in the direction of the axis of the column. The centra differ from those of *Camarasaurus* in the form of their articular extremities, resembling more nearly in this respect the genus *Tichosteus* Cope (Paleontological Bulletin, No. 26, p. 194). They are unequally amphicœlous, the posterior extremity being more concave, and with concave prominent margins; while the opposite one is less expanded and is but slightly concave. The neural arch is coössified to the centrum, and there is no capitular costal articulation on the latter.

The manner of the mutual articulation of the neural arches in this genus is peculiar, and is only paralleled in the genus *Camarasaurus*, so far as I can ascertain. The anterior zygapophyses are separated by a deep fissure, while the posterior zygapophyses are united on the middle line. From the latter from the point of junction, there descends a vertical plate which rapidly expands laterally, forming a wedge whose base looks downward. The supero-lateral faces are flat, and articulate with corresponding facets on the inferior side of the anterior zygapophyses, which look downward and inward, on each side of the fissure above described. When in relation, the anterior zygapophyses occupy a position between the posterior zygapophyses above, and the *hyposphen*, as the inferior reversed wedge may be termed, below. This arrangement accomplishes the purpose effected by the zygosphenal articulation, that is the strengthening of the articulation between the neural arches, but in a different way. The additional articulation is placed at the opposite extremity of the vertebra, and it is the anterior zygapophysis instead of the posterior one which is embraced. This structure entitles the genera which possess it to family rank, and as the two genera mentioned above belong to different families in consequence of the different types of vertebral centra, the one opisthocœlous, the other amphi-

cœloüs, they may be called *Camarasauridæ* and *Amphicœliidæ* respectively.

The pubis is a stout bone with one slightly concave, thicker border, and an opposite strongly convex, thinner margin. One extremity is truncate ; the other presents one transversely truncate and one oblique face. The femur is elongate, and presents a strong postero-external ridge or third trochanter near the middle of the shaft. The head is not separated by a well marked neck, and the great trochanter does not project beyond it.

Thus while there is a striking resemblance to *Camarasaurus* in what may be regarded as adaptive characters, in some important essentials the two genera are very different.

Amphicœlias altus sp. nov.

The centrum of the dorsal vertebra of this reptile is contracted both laterally and inferiorly, so that the margins of the articular extremities flare outwards. The sides are flat, and the inferior surface but little convex in the transverse direction. The pneumatic foramen is situated at the bottom of a large lateral fossa which extends nearly the entire length of the superior portion of the centrum. Its inferior border is sunken abruptly, while the superior gradually shallows on the external surface of the base of the neural arch. The foramen is longer than high, in contradistinction to that of the *Camarasaurus supremus*, where it is round or higher than long.

The neural arch is very much elevated to the zygapophyses. It is strengthened by a prominent rib, which extends from the posterior base upwards and forwards to the base of the anterior zygapophysis. The surface above and behind this is occupied by an extensive excavation whose superior border is the line connecting the zygapophyses. The anterior zygapophyses are separated medially by a deep notch which extends to the base of the neural spine. The articular surfaces incline towards each other. Just behind the anterior zygapophysis, a process extends outwards and forwards whose extremity is lost in my specimen. Its posterior face is excavated by the lateral fossa above described. This process is probably the parapophysis which supports the rib. The diapophysis springs from the line connecting the zygapophyses and extends upwards and outwards. Its inferior surface is concave, or longitudinally excavated.

The neural spine is thin, but its anterior and posterior borders are thickened and double, the lateral rib-like edges being separated by grooves which expand at the base. The posterior groove continues to a more elevated point than the posterior. Each side of the spine is divided into two shallow wide grooves by a median keel. The apex of the spine is much thickened transversely, its obtuse extremity having the fore and aft and transverse diameters equal.

The pubic bone resembles that of the *Camarasaurus supremus*, but is less robust in all its parts. It is also less extended in antero-posterior width near the proximal extremity.

The femur is remarkable for its slender form. It is a few inches longer

than that of the *Camarasaurus supremus*, but is not so robust. The shaft is nearly round and somewhat contracted at the middle, where it is slightly convex backwards. It is slightly curved inwards at the great trochanter. Here the shaft is moderately grooved on the posterior face. This trochanter is only a prominent ledge below the head. The third trochanter is situated a little above the middle of the shaft; it is a prominent obtuse ridge directed backwards. The condyles are extended well posteriorly, and are separated by a deep groove, which originates on the inferior portion of the shaft. They are also separated anteriorly by a shallow open groove. The external condyle is rather more robust than the internal.

The length of the femur is six feet four inches; the elevation of the dorsal vertebra three feet three inches.

Measurements.		M.
Diameter of dorsal centrum	fore and aft	.245
	vertical	.270
	transverse	.265
Total elevation of vertebra		1.100
Length of neural spine		.600
Elevation of anterior zygapophyses		.500
Diameter of neural spine	antero-posterior	.160
	transverse (at middle)	.065
	" at summit	.140
Depth of centrum below pneumatic foramen		.120
Fore and aft diameter of pneumatic foramen		.080
Length of pubic bone		1.060
Thickness of stoutest extremity		.140
Length of femur		1.524
Transverse extent of proximal end		.420
" " " condyles		.320
Diameter of middle of shaft		.220
Distance from head to third trochanter		.665
Diameter of head (compressed)		.260

Amphicœlias latus sp. nov.

Of the wonderful fauna of the Dakota epoch of the Rocky Mountains the *Camarasaurus supremus* was preëminent in several proportions, the *Amphicœlias altus* was the tallest, and the saurian now to be described, was the most robust. It is represented in Mr. Lucas' collection by a right femur and four caudal vertebræ which are in good preservation. They reveal the existence of another saurian of huge dimensions, and of great mass in proportion to its height.

The caudal vertebræ are apparently from the anterior part of the series. They are all strongly bi-concave; the anterior face more so than the posterior. They all possess diapophyses of depressed form which take their origin below the base of the neural arch. The centra are short in antero-

posterior diameter, and do not present lateral angles. They are composed of not very dense osseous tissue. The anterior zygapophyses are rather elongate, and their articular faces are directed steeply inwards. They are rceived by corresponding shallow excavations, one on each side of the posterior base of the neural spine. The neural spines are compressed and straight, and become very robust towards the apex.

The femur is extraordinarily robust. The great trochanter is low, but the shaft is widest where it expands outward. The third trochanter is above the middle, and is short and little prominent. It is on the inner edge of the posterior aspect of the shaft, and looks backwards and inwards. The shaft in its present state is compressed so as to reduce the antero-posterior diameter. It is not however crushed or cracked. The condyles have much greater transverse than antero-posterior extent. They are moderately produced backward, and are separated by a deep inter-condylar groove, while the anterior trochlear groove is wide and well marked. The inner condyle is narrowed posteriorly while the external one is obtuse and robust. The articular extremity is marked with irregular pits as in *Dystrophæus* and *Cetiosaurus*.

Measurements.

		M.
Diameter of anterior caudal vertebra.	fore and aft...	.150
	vertical.......	.200
	transverse......	.260
Elevation to zygapophyses of the same..............		.250
Total elevation of the same..........................		.480
Length of femur......................................		1.400
Proximal diameter of femur	fore and aft............	.165
	transverse	.410
Distal diameter of femur	fore and aft................	.360
	transverse.....	.450
Diameter of middle of shaft of femur................		.280

The caudal vertebræ of this species are much more deeply bi-concave than those of the *Camarasaurus supremus;* they also differ in their relatively and absolutely greater breadth of centrum.

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Descriptions of New Vertebrata from the Upper Tertiary Formations of the West.

By E. D. Cope.

(*Read before the American Philosophical Society, December* 21, 1877.)

Pithecistes brevifacies gen. et spec. nov.

Char. gen. These are chiefly known from a mandible which supports the dentition of one side and part of the other. The dental formula is I. 1 ; C. 1 ; Pm. 3 ; M. 3. The single incisor of each side is weak and easily lost, and there is on one side only, a small alveolus for a minute second incisor. It is therefore probable that in some individuals the incisive formula is 2. The canine is not large, and closes in front of the superior canine in the usual manner. The first and second premolars are one-rooted, and their crowns are wider than long. That of the third premolar is robust, but longer. The molars increase rapidly in size, and are not prismatic, but are well rooted. They are worn in the specimen, but their structure is probably shallow selenodont. The last molar has a long heel or fifth lobe.

Char. specif. The mandibular ramus is very deep posteriorly, and the incisive border is not prominent. The canine tooth is quite small, its transverse diameter being less than that of the first premolar, and equaling it antero-posteriorly. The exterior incisor is weak, and the crown expanded transversely, and obtuse. The crown of the first premolar is worn deeply by the superior canine. The transverse diameter at the base of the crown exceeds the antero-posterior. The crown of the second is wider than long, and of the third longer than wide. The molars increase rapidly in size posteriorly, so that the length of the third equals that of the three premolars plus the canine. The heel is long, and is connected with the remainder of the crown by a narrow plate, or in section, an isthmus. There are no cingula, but an accumulation at the bases of some of the teeth resembles the deposit of "tartar." The symplysis is very robust, and its upper surface is marked on each side by a low longitudinal swelling. The opposite premolar series are slightly convergent.

The form of the mandible of this animal, as well as the number and proportions of the teeth, curiously resemble that of the corresponding part of a monkey. The species was about the size of a red fox.

Measurements.	M.
Length of ramus from heel of molar III	.057
" molar series	.048
" premolar series	.015
" second true molar	.010
Width " "	.007
Length of last molar	.018
Width of " at front	.007
Length of symphysis in front	.020
Depth of ramus at first premolar	.017
" " second true molar	.025

BRACHYMERYX FELICEPS gen. et sp. nov.

Char. gen. These are derived from the superior dental series. These are I.^{2}; C.^{1}; Pm.^{3}; M.^{3}. The true molars have the bases of the crowns little swollen, and the last two of the superior series are but shortly rooted; the anterior ones have longer roots. The true molars are simply selenodont, with the anterior extremities of the external crescents forming prominent ribs. The last superior premolar consists of two columns posteriorly and a single trenchant one anteriorly, and the second (first of the series,) is simple and trenchant. The worn posterior face of the canine shows that the first inferior premolar is the functional canine as in *Oreodon.* There is a very slight diastema in front of or behind the canine, the series being continuous, as in *Oreodon.*

This genus differs from *Pithecistes* in its canine like first inferior premolar, and in the trenchant character of the anterior premolars. With *Cyclopidius* it enters the family group of the *Oreodontidæ,* but approaches the suilline types still more nearly in its probably coössified symphysis mandibuli.

Char. specif. This ungulate was a little smaller than the species last described, and is represented in my collections by two nearly complete crania without mandibles. The head is depressed and the zygomata widely expanded; the palate is wide, and the muzzle short. The infraorbital foramen is double and issues above the adjacent parts of the second and third (last) premolars. Immediately in front of it the side of the face is concave.

The projecting anterior angles of the external crescents of the molars are very prominent, forming strong vertical ribs. The external border of the last premolar is only interrupted by a little convexity. The anterior narrow portion of the second premolar is incurved. This tooth is two-rooted; the first is one-rooted. The canine is small and strongly recurved. It is cylindric at the base, but beyond this is narrowed antero-posteriorly partially from the friction of the first inferior premolar. The anterior face is regularly convex. The first premolar has a very slight internal basal cingulum; its cutting edge is directed obliquely to the long axis of the cranium. There are no cingula on the other teeth. The enamel of the true molars is smooth on the external side of the crown. There is no enamel on the inner walls of the central lakes.

Measurements.	M.
Length of dental series to anterior border of canine	.050
" premolar series	.017
" last true molar	.012
Width of " "	.006
Length of first true molar	.007
Width of " "	.006
Length of first premolar	.006
Width of " "	.006
Length of canine tooth	.009

Measurements.	M.
Diameter of canine tooth (transverse)	.004
Width of cranium between first premolars	.016
" " " last molars	.030

The cranium of this species is about the size of that of a large domestic cat.

CYCLOPIDIUS SIMUS. Gen. et. sp. nov.

Char. gen. Dental formula I. $\frac{2}{2}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{3}{3}$. The superior canine is small and is separated from the first premolar by a very short diastema. First premolar simple, trenchant; second premolar two rooted, with one principal cutting edge; third with an external crescent and a rudimental internal one, not united in front. Fourth premolar with the inner and outer crescents only, and these well developed. Last true molar without heel. Inferior canine with much wider crown than the incisors with which it is in close association. First premolar canine-like, but not very large; second premolar simple. Third and fourth premolar with the anterior portions trenchant, the posterior with wide or double columns. Last true molar with large fifth crescent or column. True molars of both jaws prismatic. Symphysis mandibuli coössified.

Frontal bones much abbreviated in front by a large upwards-looking fossa on each side, which are separated by the very narrow and short nasal bones. There are lachrymal fossæ and a huge foramen in front of them, which communicate with the maxillary sinus. There is a prominent transverse supraoccipital crest, and the otic bullæ are greatly inflated.

This genus is related to *Leptauchenia*, Leidy, but differs in having but two lower incisors below. That genus belongs to a lower horizon, the miocene of White River, while the present form is its successor in the upper Miocene or Loup Fork beds. The remarkable character of the vacuities in the superior region of the front part of the cranium, reminds one of the existing genus *Sæga*. Dr. Leidy partially described a similar structure in *Leptauchenia*. In this genus what are clearly nasal bones in *Cyclopidius*, he terms frontals, probably by error.

Char. Specif. This animal is rather larger than either of those above described, and is represented in my collection by one nearly complete cranium, one entire left maxillary bone, and the under jaws of five, and probably of several other individuals.

The skull is wide and abbreviated in front. The maxillary bones are everted on each side of the external nares. The malar bone is very wide or deep, and sends upwards a strong postorbital process, which is broken off in part, but which probably completed the orbit. The superior facial fossæ reach backwards nearly as far as the middle of the orbit. They are longitudinal narrow ovals, open in front. The projecting supraorbital portions of the frontal bone with the nasals have a tripodal form. The lachrymal fossa looks outwards, upwards and forwards, and the large maxillary foramen outwards. The infraorbital foramen is double, and issues above the contiguous portions of the third and fourth premolars.

The external crescents of the true molars present prominent anterior angles, which form strong vertical ribs. The first superior premolar has a weak, and the second premolar a very strong internal basal cingulum ; there are no other cingula. The diastema is as wide as the diameter of the canine.

The first inferior premolar is one-rooted, and the second two-rooted, and both are longer than wide in horizontal diameter. The middle pairs of incisors are very small ; the external one on each side is much larger, the diameter equaling half that of the canines. The first and second true molars are subequal, and are together longer than the third, which does not quite equal in length the three premolars. The heel of the last molar is not so long anteroposteriorly as each of the other columns. The symphysis is steep, but is everted at the incisive region.

Measurements.	M.
Length of ramus from heel of m. III	.065
" of molar series	.036
" of premolar series	.016
" of second true molar	.011
Width of " " "	.006
Length of third " "	.016
Width of " at front	.006
Length of symphysis in front	.025
Depth of ramus at first premolar	.022
" " second true molar	.025
Width between superior anterior premolars	.014

Cyclopidius heterodon sp. nov.

This species is represented by a portion of the right maxillary bone, which supports the last premolar, first true molar, and portions of other teeth. It is a smaller form than the *B. simus*, and differs in several important respects. The infraorbital foramen is single and larger than those of the other species. The fourth premolar, while of the same constitution as that of *M. simus*, is relatively much smaller, not equalling in the extent of its grinding face one column of the first true molar. The latter is prismatic, and of usual form. Its external crescents are not produced as in *B. simus*, so that there are no distinct vertical ribs.

Measurements.		M.
Diameter of last premolar	anteroposterior	.0050
	transverse	.0045
Diameter of first true molar	anteroposterior	.0080
	transverse	.0055

This species was found with the three preceding in the Upper Miocene of Montana by my assistant, J. C. Isaac.

Blastomeryx borealis sp. nov.

This genus was defined by me in the fourth volume of the Report of Lieut. G. M. Wheeler to the Chief of Engineers, 1877, p. 350, as not cer-

tainly distinct from *Dicrocerus* Lartet. The discovery of a second species of the group, which displays the characters there pointed out, in a still more striking degree than the species on which it was formed, renders it necessary to introduce the genus formally to the system. In brief its molars differ from those of *Dicrocerus* much as those of the deer differ from the molars of the antelope. While *Dicrocerus* was probably the ancestor of *Antilocapra, Blastomeryx* was the ancestor of *Cervus* or *Cariacus*.

The superior dental formula is I. 0; C. 0; Pm. 3; M. 3. The molars all have two pairs of crescents excepting the last premolar, where the posterior pair are rudimental. The external face of the anterior crescent in all the molars presents a groove, which is bounded posteriorly by a vertical ridge. The posterior crescent is directed a little inward posteriorly on the true molars. The palate is much contracted in front of the first molars. The horns stand above the posterior parts of the orbits; their section is triangular, the posterior angle being rounded, and the external produced and acute, bounding the orbit outwards and backwards. There is no trace of burr. The temporal fossæ approach so as to be separated only by a rather wide and low occipital crest.

Measurements.	M.
Total length of skull	.320
Length of molar series	.107
" premolar "	.049
" second premolar	.016
Width " "	.011
Length of first true molar	.020
Width " "	.015
Width between bases of horn-cores	.050
Transverse diameter of horn-core two inches from base	.040
Width between external borders of first true molars	.078
Width of palate in front of first premolars	.028

This species was as large as the black-tailed deer, *Cariacus macrotis*. It was found by my assistant, J. C. Isaac, in the Upper Miocene of Montana.

Cervus fortis sp. nov.

This deer is of large size, much exceeding any living species of the family *Cervidæ*. It is represented in my collections by a superior molar of the left side, and very probably by other remains which accompanied it, viz.: a mandibular symphysis with incisor and canine teeth; calcaneum. astragalus, vertebræ, etc. These were found at the same time and place by George M. Sternberg, M.D., U. S. A., already well-known by his interesting discoveries in the cretaceous formation of Kansas.

The plicæ which mark the anterior extremities of the external crescents are very prominent, and are directed forwards rather than outwards. The median lakes are narrow and well separated medially. The posterior lake has a strong fold of its internal border, forming a lobe directed backwards.

A cylinder of small diameter stands near the apex of the fold of the internal enamel wall, which separates the internal crescents. There is a cingular ridge descending inwards on the interior and posterior extremities of the base of the crown, and below and exterior to it the enamel surface is very rugose. The surface of the external enamel is smooth. The enamel of the lake borders is seamed with shallow vertical sulci. The crescents are wide and the lakes narrow.

The reference of this species to the genus *Cervus* may require reconsideration.

Measurements.	M.
Anteroposterior diameter of crown	.052
Transverse do. in front	.035
Width of anterior external crescent	.018
Elevation of crown externally	.020

From the pliocene formation of Oregon.

The Loup Fork beds have been usually referred to the Pliocene horizon, but I have offered reasons why they should be regarded as of Upper Miocene age. The horizon from which this and some other species herein described, found in Oregon, represent the Pliocene formation much more nearly.

DICOTYLES SERUS, sp. nov.

This species of hog is indicated by a mandibular ramus which lacks the angles, and supports the dentition of both sides excepting the third right molar. Other portions of the skeleton are associated. A second specimen is the symphysis with the incisor teeth. The remains indicate an animal something larger than the white lipped peccary *Dicotyles labiatus.*

Dentition of the mandible, I. 2 ; C. 1 ; P. m. 3 ; M. 3. Inferior canines triangular ; superior canines decurved, triturating the inferior. Last inferior molar with well developed heel. Last premolar like the first molar. First premolar with anterior single tubercle and posterior lower tubercle heel ; second premolar similar but wider, and the anterior tubercle divided. Molars consisting of four principal tubercles opposed in pairs, with some accessory ones between them.

The rami are robust and of moderate depth ; the symphysis is elongate and contracted. The suture of the latter remains on the inferior side, but is obliterated on the upper surface. The symphysis is trough-like and the narrow alveolar ridges of the diastema are concave inwards.

The incisor teeth are directed forwards, and are closely approximated and parallel. The fang of the second lies close to that of the canine, and the edges of the crowns together form a parabola, the enamel being prolonged posteriorly on the external side of the external tooth. The crowns of the median teeth are not expanded laterally, nor much depressed at the apex ; as half worn in the specimen, they form a wide transverse oval. The canines curved upwards and outwards and present their triturating surface a little external to directly backwards. Their section is tri-

angular, the lateral faces being longer than the posterior, and the anterior angle is a narrow one. The surface of the enamel cannot be described, as it is eroded at some points. The diastema is long.

The first (homologically second) premolar is narow, and is without lateral or posterior lobe or cingulum, but a third is a rudimental lobe at its anterior base. The heel presents an interior tubercle, and a narrow postero-external lobe which embraces a medeo-external tubercle. The latter becomes the external posterior tubercle on the true molars. The third premolar is larger and wider than the second ; the medio-external lobe becomes more external and posterior, and a median tubercle appears in front of it. The posterior tubercle still sends a narrow ledge round to the outer base of the medio-external lobe. The anterior lobes are more elevated than the others, and are only separated by a fissure. In the fourth premolar the true molar structure is seen in the regular quadri-tuberculate form. There is a small tubercle in front and behind the notch of lobes, and a fold descending forwards on the outer side of the external posterior lobe. In the second true molar there is an additional tubercle on the middle line between the pairs of lobes. The median accessory tubercles are not distinct on the last molar, excepting the posterior, which becomes a large heel. The lobes of each pair are not deeply separated on the last two molars. These teeth are rather abruptly larger than the first true molar, which is little larger than the last premolar. Each of them has a narrow anterior cingulum, but no other. The enamel is nearly smooth.

Measurements.		M.
Length of mandible from end of posterior molar to incisive alveoli		0.190
Length of molar series		.103
" true molars		.062
" diastema		.054
Width between bases of canines		.020
" of diastema		.024
" between bases of first premolars		.032
Diameter of p. m. 2	antero-posterior	.012
	transverse	.007
Diameter of p. m. 4	transverse	.015
	antero-posterior	.012
Diameter of m. 2	antero-posterior	.021
	transverse	.016
Diameter of m. 3.	antero-posterior	.026
	transverse	.015

The animal from which the above description was taken was adult. It was discovered in the Loup Fork beds of North-Western Kansas by Russell Hill of this city.

TETRALOPHODON CAMPESTER sp. nov.

The cranium and under jaw, with nearly complete dentition, including tusks, of this species, were obtained by my assistant, Russell S. Hill. The

animal is mature but not old, as the second true (third intermediate) molar is present and much worn, and the last molar is worn on its anterior three-fifths.

The posterior or fourth crest of the second true molar is narrower than the third, and is not followed by a heel. The third molar presents six transverse crests, and so large a heel that it might be said to be seven-crested. Each crest is sub-transverse, and is composed of a principal obtuse cone at each extremity and some smaller ones between, in close contact. The apices of the larger ones approach each other, and the median ones are less elevated. The section produced by wearing of the third and second crest each, is that of two trefoils placed base to base, and the lateral lobes of these, completely close the valley between those crests. The valleys between the other crests are closed by one or two distinct median tubercles, and the sections of those crests are less accurately trifoliate than those of the others. There is a very large cingulum at the anterior extremity of this tooth whose worn section is confluent with both of the trefoils of the anterior crest near the middle. A portion of it is isolated on the inner side of the crown, forming a flattened cone, or when worn, an isolated oval with the long axis directed inwards and forwards. This I have counted as the first crest, as it is as much entitled to it as the one so counted by Dr. Falconer, in the *T. sivalensis*. The palate is narrow, not exceeding the width of the second true molar.

The mandibular rami are of rather light tissue, and are compressed in form, the external face being little convex. The symphysis is produced, without abrupt contraction either laterally or below, into a robust beak whose depth is equal to the width five inches beyond the bifurcation. It is channeled above by a narrow and deep groove, and supports no tusks. From the appearance of the tissue when fractured transversely it is evident that there have been no alveolar cavities at any time. The beak is slightly decurved and the extremity is depressed and transversely flattened. The superior incisor possesses a broad band of enamel, which covers nearly one-third the diameter of the tooth.

Measurements.	M.
Length of crown of second true molar	.118
Width " " "	.075
Length " third "	.195
Width " " "	.080
" palate at anterior extremities of second molars	.045
" " posterior crests of third "	.095
Length of ramus from posterior border to bifurcation	.560
Length of symphyseal beak (broken)	.480
Depth of do. five inches from bifurcation	.118
Width of do. at do.	.115

This fine new *Mastodon* is the second species of the genus *Tetralophodon* found as yet in North America, the first being the *T. mirificus* of Leidy.

It is well distinguished from this form by the structure of the component parts of the crown of the last molar tooth, and by its long symphysis, that of the *T. mirificus* possessing the more usual short spout. It is with the *T. longirostris*, of Eppelsheim and the valley of the Danube, that the closest affinity exists. In *T. campester* the symphyseal production is much more robust, not being separated from the rami by any constriction, as in *T. longirostris.* It is moreover without incisive tusks, but it is yet uncertain what value should be attached to this character, as it may turn out to be individual or sexual. In the intimate structure of the molars there is considerable resemblance to the *T. longirostris;* that species is however stated by Dr. Falconer* to possess but five crests and a heel on the last molar. The presence of the enamel band on the tusks also separates the *T. campester* from that species, where, according to Mr. Vacek,† it is wanting.

In comparison with *M. sivalensis*, this Mastodon differs in the transverse character of the valleys; in the Indian species the tubercles alternate and close them.

The dimensions of the *T. campester* are those of the African Elephant.

From the Upper Miocene and Loup Fork horizon of Kansas.

Taxidea sulcata sp. nov.

This badger is represented by the nearly entire maxillary bone of the left side containing all the teeth excepting the canine and first premolar. It resembles the corresponding portion of the *T. americana* very nearly, but differs in two important features. The first of these is the abbreviation of the anterior portion of the dental series. The first premolar is closely wedged in between the canine and second premolar, so that its anterior root is almost obsolete. The head was thus doubtless relatively shorter than in the existing species where there are hiatuses between the roots of the first premolar and adjacent teeth. The second character is seen in the last or true molar. On its crown the tubercles are arranged in two well separated transverse rows, forming crests by their confluence, which are separated by a deep valley, and bound by a half valley in front and rear.

Measurements.	M.
Length of series, including canine	.038
" premolars	.023
" last premolar	.011
Width of " "	.009
Length of last molar (inside)	.012
Width " "	.010

From the Pliocene of Washington Terr.; found by Major Truax, U.S.A.

* On British and European Fossil Mastodons, p. 19 (8 vo.).

† Ueber Oesterreichische Mastodonten Wien, 1877, p. 31 (Abh. K. K. Geol. Reichanstalt).

PSEUDEMYS BISORNATUS sp. nov.

This fresh water tortoise is represented by portions of three individuals. These exhibit a rather flattened convex carapace, with marginal bones united (behind the bridge at least), without gomphosis, by fine suture. There are no median or lateral keels. The vertebral bones are nearly as wide as long, and thick ; the costals are thickest proximally and thinnest medially. The marginals are quite stout. The dermal scutal sutures are deeply impressed, especially those defining the marginal scuta.

The sculpture of the superior surface of the carapace is strongly marked and peculiar. The vertebral scutal areæ are smooth, or display only a few obscure ridges directed backwards and inwards, on the proximal portions of the costal bones ; the vertebral bones being smooth. The costal scuta present two forms of sculpture ; posterior to the intercostal bony suture each is reticulated with inosculating sharp ridges whose general direction is longitudinal proximally and transverse distally. The sculpture is Trionyx-like, and rather coarse. The surface anterior to the osseous suture, is ornamented with raised, parallel ridges, which are separated more widely than those of the posterior half of the scutum, and which do not inosculate. They continue uninterruptedly to the succeeding osseous suture, to be followed again by the reticulate pattern. Thus each costal bone is divided into three areas ; a proximal smooth one, and an anterior reticulate, and posterior ridges areæ, separated by a deep sutural groove.

A postero-lateral marginal bone unites subequally with two costals. Its superior surface rises in abrupt convexity beyond the costo-marginal dermal suture, and from the transverse intermarginal dermal suture. It is then concave to the recurved margin. Its sculpture consists of transverse ridges, separated by grooves of equal width.

Measurements.	M.
Length of a vertebral bone	.035
Anterior width of same	.032
Thickness of same anteriorly	.009
Extent of median costal { antero-posterior	.035
Extent of median costal { transverse	.117
Median thickness of do	.006
Distal " "	.007
Length of a posterior marginal	.030
Width " "	.042
Thickness " "	.017

This tortoise is at first sight apparently singular in its marks of ornamentation. On comparison with existing species, however, it is seen to present an exaggerated condition of the sculpture characteristic of some of the existing *Pseudemydes* of our Southern rivers ; e. g. the *P. elegans*. It is more robust in all its proportions than any of these.

The fossil remains were discovered by my friend, G. W. Marnock, in the pliocene of South-western Texas.

Cistudo marnochii.

Represented by the posterior lobe of the plastron of an individual of twice the bulk of the existing North American *Cistudos.* It is broadly rounded posteriorly, and there is an emargination at the femoro-anal dermal suture. The anterior suture is straight, as is also the lateral, which measures more than a third the length of the entire lobe. On the upper side of the angle included by these sutures is the fossa for fixed attachment with the carapace. The beveled face of the fore edge of the lobe is quite wide. The dermal sutures are well marked. The anal scuta are large, their median length being half that of the lobe. The common femoral suture is only half as long as the ventral. The inferior surface is nearly flat in every direction; and the surface is smooth. The posterior border of the specimen is broken away.

This species was obtained from the same formation as the last, by Gabriel W. Marnock, to whom I dedicate it.

Anchybopsis breviarcus sp. nov.

The genus to which the above name was given, was established by the writer in 1870, for a species Cyprinoid fish, from the pliocene formation of Idaho. Its affinities were then stated to be to *Alburnops* (*Hybopsis*), and related existing genera. The present paper describes two additional species of the genus, both of which are represented by pharyngeal bones and teeth of both sides. The teeth are shown to be 5–5, in contradistinction to the genera *Hemitremia* and *Alburnops*, where they are 5–4 and 4–4 respectively

In this fish the common base of the pharyngeal teeth rises upwards, so as to project well in front of the general plane of the bone. The superior teeth are more compressed than the inferior, and the first and second counting from below, have convex grinding faces. The pharyngeal bone has a short inferior and a long superior limb. The alate portion is regularly and strongly convex, without abrupt expansion. The nutritive foramina of the anterior face are two large inferior and several small superior ones.

Measurements.	M.
Vertical extent of bone in a straight line	.020
Width at second tooth	.008
" at first "	.004
Length of tooth line	.011
" of third tooth	.005
" of basal limb to first tooth	.009

This species is of smaller dimensions than the *A. latus.*

Anchybopsis altarcus sp. nov.

The pharyngeal bones of this cyprinoid are larger and of more slender proportions than those of the *A. breviarcus.* Specimens from both sides are preserved. The inferior and superior limbs are both elongate, the former slender, the latter flat. The ala is abruptly expanded at right angles to the long axis; the external border is thence nearly straight to, and the angle of

the superior border situated interiorly to, the line continuing the inner border upwards. The tooth line is elevated at the upper extremity. The basal teeth are more robust than the others, and do not present grinding faces. The nutritive foramina are more numerous and smaller than in the *A. breviarcus.*

Measurements.	M.
Vertical extent of right pharyngeal	.023
Width at second tooth	.009
" at first "	.004
Length of tooth line	.012
" of third tooth	.006
" of basal limb to first tooth	.011

Found with the last species by Chas. H. Sternberg, in the Pliocene deposit of Oregon.

ALBURNOPS ANGUSTARCUS sp. nov.

Represented by the pharyngeal bones of both sides, of a species of about the size of the one last described. The characteristic marks of these are seen in the long extremities, both inferior and superior, and in the very slight convexity of the ala, which is less prominent than in any of the *Cyprinidæ* here described. The superior end of the tooth basis is elevated and prominent. In one of the jaws all the teeth display a masticating surface. In the other the second tooth, the only one preserved, is partially worn.

The length of the proximal limb distinguishes this pharyngeal bone from that of the *Anchybopsis breviarcus,* if the generic characters be disregarded. From all the other species the slight prominence of the ala separates it.

Measurements.	M.
Vertical extent of right pharyngeal	.023
Length of proximal limb	.010
" of tooth line	.010
" of distal limb	.012
Width at first tooth	.005
" of second tooth	.007
Length of third tooth	.005

Found by Mr. Sternberg, with the last species.

ALBURNOPS GIBBARCUS sp. nov.

One left and two right pharyngeal bones furnish the characters of this species. Their form is angulate, as in the *Anchybopsis altarcus,* but shorter in the vertical direction. The proximal limb is rather short, and the distal one not as long as in the species last described. The ala widens abruptly at the inferior margin, and the thin superior edge of the superior limb is obtusely angulate. The nutritive foramina are rather numerous. The first and second teeth display little or no grinding surface.

Measurements.	M.
Vertical extent of right pharyngeal	.020
Length of proximal limb	.009
" of tooth line	.009
" of distal limb	.009
Width at first tooth	.004
" at second tooth	.008
Length of third tooth	.005

Found by Chas. H. Sternberg in the Pliocene of Oregon.

On some Saurians found in the Triassic of Pennsylvania, by C. M. Wheatley.

By E. D. Cope.

(Read before the American Philosophical Society, Dec. 21, 1877.)

Thecodontosaurus gibbidens sp. nov.

The only remains of this saurian which have come into my hands are two teeth. They are in good preservation, lacking only the great part of the root. They present the leaf-like outline characteristic of the genus, the crown being strongly distinguished from the narrower root. The form is quite robust, and contracts gradually to the apex. The cutting anterior and posterior edges bound the inner face of the crown, from which they are separated by a groove along their bases. They are interrupted by coarse serrations, the apices of the denticles being directed upwards. These are much reduced in size at the base of the crown. The cutting edges are not separated from the external face by grooves. This face is very convex and perfectly smooth. The inner face is convex between the grooves and is marked with six or seven continuous sulci, which are obsolete at the base.

The saurian which possessed the tooth described was not of large proportions. The species differs from the English form in many respects ; e. g., the greater convexity of the external face ; the basal grooves of the cutting edges, the grooving of the inner face, the abrupt constriction below the base of the crown, etc.

Measurements.		M.
Diameter of crown	antero-posterior	.0070
	transverse	.0045
Length of crown		.0038

PALÆOSAURUS FRASERIANUS sp. nov.

But few remains indicate this species. It is established primarily on a tooth, which presents the characters of *Palæosaurus cylindrodon.* It has opposite denticulate cutting edges, an anterior and posterior, of which the latter extends to the base of the crown, and the anterior but half way from the apex. The posterior is denticulate throughout, while denticulation is visible on the anterior edge for but one-third the distance from the apex. The posterior edge is more compressed. The surface of the cementum is obsoletely finely linear ridged, and there are no sulci or other sculpture. The crown is regularly and gently curved backwards.

Measurements.	M.
Length of the crown	.0200
Antero-posterior diameter of crown at base	.0065

This saurian is dedicated to my friend, Persifor Frazer, Jr., in charge of one of the districts into which the State of Pennsylvania is divided for the conduct of the second geological survey. This district embraces the Triassic region, which has been extensively and ably investigated by Prof. Frazer.

SUCHOPRION AULACODUS Cope.

Palæoctonus aulacodus Cope, Paleontological Bulletin, No. 26, p. 184.

Several additional teeth of this species show that the tooth from which I first determined it is one of the flattest of the series, and that those from other positions in the jaws, instead of being flatter as in *Palæoctonus,* are narrower, and of the usual form of those of *Suchoprion.*

This saurian possesses teeth of the size of the average of those of the *S. cyphodon,* and which are like them, well compressed in the antero-posterior direction. The surface is therefore very convex between the cutting edges, especially on the external face, and the transverse diameter at the base of the crown exceeds the antero-posterior. The cutting edges only extend half way from the apex, and are but little denticulated. The surface of the cementum is minutely and sharply linearly sculptured. It is in addition, thrown into coarse continuous grooves on the basal two-thirds of the crown, excepting for a short distance on the inner side of each cutting edge. There are seven grooves on the inner face, and eighteen on the outer face. On the latter the minute sculpture is least distinct.

Measurements.		M.
Length of crown		.0260
Diameter of base of crown	fore and aft	.0160
	transverse	.0115

The short slightly denticulate cutting edges and the strongly grooved surface distinguish the anterior teeth of this species at once from the *S. cyphodon.* Several specimens have been found by Mr. Wheatley.

On the Vertebrata of the Dakota Epoch of Colorado.

By E. D. Cope.

(*Read before the American Philosophical Society, December* 21, 1877.)

Not long since I was informed by the Superintendent of Public Schools of Fremont County, Colorado, Mr. O. W. Lucas, that he had discovered the bones of an enormous saurian at an outcrop of the rocks of the Dakota group not far from Canyon City. I encouraged him to proceed with the exploration, and asked him to send some specimens which would explain the character of his discovery. One of the first objects sent, is a fragmentary lower jaw of a carnivorous dinosaurian, which he found on the surface of the ground. This fossil was found to belong to a species heretofore unknown, which I referred to the genus *Laelaps*, under the name of *Laelaps trihedrodon.** The second sending included a number of vertebræ, which apparently represent a much more gigantic animal, and I believe the largest or most bulky animal capable of progression on land of which we have any knowledge. This reptile I described in my paleontological bulletin No. 26, under the name of *Camarasaurus supremus.* Subsequent sendings included many of the more important bones of the skeleton, which render it comparatively easy to determine the general character of this monster. Later collections received from Mr. Lucas include the teeth of two large species of a new genus which has been characterized under the name of *Caulodon;* and the vertebræ of three genera new to science, which I have named *Tichosteus,* and *Symphyrophus.* He also procured remains of two additional forms of gigantic size, fit rivals of the *Camarasaurus,* which I referred to the new genus *Amphicœlias.* A species of tortoise was associated with these saurians, and appears to have been abundant. It is the oldest species of the order yet obtained from American formations, and is not very different from existing forms.

The above named genera are the only ones from the Dakota horizon of this continent which have been defined, up to the present time.

The species of *Camarasaurus* and *Amphicœlias,* which attained to the most gigantic proportions, are remarkable for the light construction of the vertebræ anterior to the tail. In both genera the centra of the dorsal vertebræ are hollow, including two large chambers which are separated by a longitudinal median wall, and which communicate with the cavity of the body by a foramen on each side. They are also remarkable for the enormous elevation of the superior arches, and diapophyses, the result of which is to give the ribs an unusually elevated basis, and the cavity of the body much space above the vertebral axis on each side. On the other hand the bones of the tail and limbs are solid or nearly so, in great contrast with some of the *Dinosauria* of later geological periods. Another peculiarity of the genus *Camarasaurus* at least, is the probable great length of the an-

* Bullet. U. S. Geol. Surv. Terrs. III, 1877, p. 805.

terior limbs. The scapula is enormous as compared with the pelvic bones. The sacrum is also small and short, showing that the weight was not borne on the hinder limbs. The great length of the humerus in the probably allied genus *Dystrophæus*, from the Trias of Utah, adds to the probability that the same bones were large in *Camarasaurus*. This character, taken in connection with the remarkably long neck possessed by that genus, suggests a resemblance in form and habits between those huge reptiles and the giraffe. While some of the later *Dinosauria* elevated themselves on their hind limbs to reach the tree-tops on which they fed, the general form of the body in some of these earlier types enabled them to reach their food without the anterior limbs leaving the earth.

Another remarkable peculiarity which these genera share with *Dystrophæus* and *Cetiosaurus* is the irregular and pitted character of the articular extremities of some of the bones. This indicates a cartilaginous covering, and probably in some instances an osseous cap or epiplysis.

Dr. Hayden visited the locality of Mr. Lucas' excavations, and informs me that the formation from which the *Camarasaurus* was obtained, is the Dakota. Prof. Marsh has attempted to identify what is, according to Prof. Mudge, the same horizon, one hundred miles north of Canyon City, with the Wealden of England. Specimens from the northern locality which I have examined render it certain that the horizon is that of Mr. Lucas' excavations. Of this I may say that there is no paleontological evidence of its identity with the Wealden. The resemblance of the vertebrate fossils to those of the English Oolite is much greater, but not sufficient as yet for identification.

The discovery of *Vertebrata* in the strata of the Dakota epoch is an important addition to the geology and paleontology of North America. The numerous geologists who have explored its outcrops have failed hitherto to observe remains of this class of animals. Credit is due to Superintendent O. W. Lucas for this discovery, and also in an especial manner for the skill and care he has exercised in taking out and shipping the ponderous specimens.

CAMARASAURUS Cope.

Palæontological Bulletin No. 25, p. 5; (published August 23, 1877).

The characters of this genus are derived from nearly all portions of the skeleton excepting the skull and ungues. The bones are generally in good preservation.

The vertebræ of the cervical, dorsal and lumbar region are all opisthocoelous or reversed ball and socket. The centra of the cervicals are very elongate, but those which follow them diminish rapidly in length, until in the lumbar region they have but a small anteroposterior diameter. The anterior caudal vertebræ are also very short and wide; but the length of the centra gradually increases, so that the distal ones are quite elongate. The caudal centra are all moderately amphicoelous.

The centra of the cervicals and dorsals are hollow, and the interior

chambers communicate with the cavity of the body by a large foramen on each side, which is below the base of the diapophysis. In the cervical vertebra it is very elongate, and extends between the bases of the parapophysis and diapophysis. In the dorsal centra there are but two chambers, which are separated by a longitudinal median septum.

The neural arches are coössified with the centrum throughout the column. They are extraordinarily elevated, and their antero-posterior diameter is small. The zygapophyses are at its summit, and have extensive articulating surfaces. The anterior pair are divided by a deep median fissure, while the posterior are united, and support as a pendant from their inferior median line a *hyposphen*, a structure more fully described under the head of the genus *Amphicoelias,* where it is equally developed. When the vertebræ are in relation, the base of the hyposphen enters the fissure between the anterior zygapophyses, and maintains them in position. This structure is obsolete in the lumbar vertebræ.

The diapophyses rise from the neural arch to a considerable length upwards and outwards, in the anterior dorsals. They become shorter posteriorly, but in none of the vertebræ anterior to the sacrum do they issue from the centrum. In the caudal vertebræ they are short and robust, and issue from the superior part of the centrum, They do not continue far on the tail. Those of the dorsal vertebræ are light and concave below. They are supported by thin osseous buttresses, the most important of which are the two inferior ones. The anterior of these is much the most prominent, and bears the capitular articular facet for the rib. In no case is this surface seen on the centrum, but it descends somewhat in the posterior vertebræ, but not as low as the level of the neural canal.

The neural spines are rather short, and are set transversely to the axis of the animal. The superior portion is expanded transversely, and in an anterior dorsal vertebra, is widely emarginate above, so as to appear double. The neural spines of the caudal vertebræ are compressed and elevated, though thickened at the apex. The zygapophyses are situated low down, and are directed very obliquely. The chevron bones of the caudal vertebræ have short limbs which are not united at the base, and a long common median spine.

The sacrum is short and consists of only four vertebral centra, thoroughly coössified. The anterior articular extremity is convex; that of the posterior extremity slightly concave. Its transverse processes are, like those of the other vertebræ, much elevated, although they spring from the centra. The external face of their bases is not prominent, and the spaces between their projecting portions are deeply excavated. The centra are like those of the caudal vertebræ, composed of dense bone. The extremities of the adjacent transverse processes are united, thus enclosing large foramina.

The scapula is relatively of large size. It is rather elongate, and the superior extremity is expanded. There is a very large mesoscapular process, which is wanting in *Cetiosaurus,* according to Phillip's figures. It appears to resemble the scapula in *Dystrophæus*.* The two proximal faces,

*See Report of Lt. Wheeler, Vol. IV, pl. LXXXIII, p. 31.

the glenoid and the coracoid, are well distinguished, and their surfaces are like the corresponding faces of other bones, pitted coarsely.

The coracoid bone is of proportionately small size. It is of an irregularly quadrate form, with the proximal extremity the shortest. The articular face is large, and is presented obliquely away from the long axis of the plate. There are no emarginations nor intermediate processes, and the perforating foramen is well removed from the border.

Pelvic bones of two forms are present. Neither of them resembles pelvic bones of *Dinosauria*, and are least of all similar to the forms of ilium which are known in that order. One of them is a robust L-shaped bone, one limb of which is expanded into a wide fan-shaped plate ; and the other is stouter and of sub-equal width, terminating in a stout sub-triangular articular extremity. The face of this limb of the bone which looks away from the fan-shaped plate is concave throughout its entire length, forming a large part of the acetabulum. Both edges of this cavity are free and rounded. The absence of articular faces above the acetabulum renders the identification of the bone with either pubis or ischium difficult. The second pelvic bone is larger than the first, and unlike it, is in one plane. Its form is that of a low triangle with a long base, at each extremity of which the angles are truncated. The "basal" border is gently concave in the long direction and thick and convex in the cross-section, The two "sides" of the triangle are rather thin margins, but one of them is thicker than the other. One extremity of the bone is more robust than the other, and is divided into two planes. The one is transverse and sub-triangular, and applies to the extremity of the stout or acetabulum limb of the other pelvic bone. The other is smaller, is oblique and concave, and when the two bones are placed in relation, forms a continuation of the acetabular surface already described. Within this and the proximal portion is a large foramen which resembles the pectineal perforation of the pubis.

The femur is long and without prominent third trochanter, this process being represented by a low ridge. The condyles have an extensive posterior sweep, and are separated by a shallow trochlear groove in front. A tibia which was found with the other bones, is much shorter than the former, and has a much expanded head. It is very robust, especially at the distal extremity. The astragalus was evidently distinct from it. A metapodial bone is very robust. Its extremities are much expanded, and the shaft contracted, and it is furnished with a prominent median keel on one half of its posterior aspect.

Several genera have been described, which possess some of the features presented by those to which the present animal belongs. The following are characterized by the presence of the lateral sinuses of the vertebral centra : *Megadactylus* Hitch., *Cetiosaurus* Owen, *Ornithopsis* Seeley, *Bothrospondylus* Ow., and *Pneumatarthrus* Cope. The first of these may be dismissed with the remark that its caudal vertebræ possess the sinuses as well as the dorsals, which we have seen is not the case with the Colorado animal. The centra of *Cetiosaurus* according to Owen, and those of

Pneumatarthrus, do not exhibit the cavernous structure above described, but are uniformly spongy interiorly. *Ornithopsis* of Seeley, which Owen refers to his subsequently described *Bothrospondylus*, possesses a cavernous cellular structure, which I have not found in the reptile from Canyon City, Colorado, but which occurs in the huge saurian discovered by Prof. Lakes, near Golden, Colorado, in the same stratigraphical horizon. Another name (*Chondrosteosaurus*) has been introduced by Prof. Owen, but he gives no characters, nor points out how it differs from *Ornithopsis*, which it resembles in its cellular structure.

A short time prior to my publication of the description of the genus *Camarasaurus*, Prof. O. C. Marsh of New Haven issued a description of a portion of a sacrum of a saurian found in the Dakota beds near Morrison, Colorado, a point one hundred miles north of Canyon City. To the animal to which the sacrum belonged, Professor Marsh gave the name of *Titanosaurus montanus*. As the name of the genus was not accompanied by any generic diagnosis or specific reference to its characters, it has no claim to adoption according to the rules of nomenclature, nor is the genus distinguished from some of those above enumerated. Especially is there nothing to indicate that it differs from *Ornithopsis* or *Bothrospondylus*. The name given has also been already employed by Dr. Lydekker of the Geological Survey of India.

Camarasaurus supremus Cope.

Paleontological Bulletin, No. 25, p. 7; Aug. 1877.

The bones of this species so far discovered by Mr. Lucas are:—a cervical and twenty dorsal and lumbar vertebræ, with twenty caudals. Both scapulæ and coracoids were recovered, with one-half of the sacrum, and two pairs of pelvic bones. Of the hind limb I have the femur, with a tibia less certainly belonging to the same animal, although found among the other bones. There is one metapodial. There are many other bones which I have not yet reconstructed or determined.

The dimensions of this animal may be inferred from the fact that the cervical vertebra is twenty inches in length and twelve in transverse diameter; and that one of the dorsals measures three and a half feet in the spread of its diapophyses, two and a half feet in elevation and the centrum thirteen inches in transverse diameter. Another dorsal is two feet ten inches in elevation. The scapula is five and a half feet in length and the femur six feet.

The centra of these vertebræ bear a ball and socket articulation of the opisthocoelian type, the cups and balls being well pronounced ; just beneath the diapophysis is situated a huge foramen. A broken centrum from which Mr. Lucas removed the matrix, shows that this foramen communicates with a huge internal sinus, which occupies almost the entire half of the body of the vertebra. Those of opposite sides are separated by a septum which is thin medially. Thus the centra of the dorsals are hollow. The neural arches are remarkable for their great elevation, and the great expanse of the zygapohpyses. They are more remarkable for the

form of the neural spines, which are transverse to the long axis of the centrum. That of one of the vertebræ is strongly emarginate so as to be bifurcate. The widely extended diaphophyses support the rib articulations, and there are no capitular articular facets on the centra.

The cervical vertebra is depressed, the anterior or convex extremity of the centrum the most so. It is remarkable for its elongate form, exceeding the proportions found in known *Dinosauria* and *Crocodilia*, and resembling that seen in some fluviatile tortoises. Near the anterior extremity a short, robust parapophysis has its origin, from which it extends outwards and downwards, and soon terminates in a truncate extremity which presents downwards. A deep fossa occupies its upper base, and above this a deep linear foramen extends throughout the greater part of the length of the centrum. If this vertebra possesses a diapophysis it is rudimental.

The caudal vertebræ are amphicœlian, but not deeply so. They are subquadrate in section, and not so short as the corresponding ones of *Hadrosaurus*. The most anterior one of the series has short, robust diapophyses, and is more concave anteriorly than posteriorly. The other caudals are more equally biconcave, but the cavity is very shallow on the most distal of them. The centrum is relatively more elongate and compressed than those of the others. None of them display the lateral pneumatic fossa which exists in the dorsals, and where broken so as to permit a view of the internal structure, the latter appears to consist of rather finely spongy tissue. The chevron facets are not very well defined, and the neural spines are of usual forms, and on two anterior vertebræ elongate.

Many peculiarities are exhibited by the vertebræ of this species, which are not described in saurians known up to the present time. Many of these would have been lost in less careful hands than those of Mr. Lucas, and science is much indebted to him for the preservation of many walls and buttresses of light proportions. In general the external walls of the centra are thin, and the processes are composed of laminæ united by narrow margins. The vertebræ are lighter in proportion to their bulk than in any air-breathing vertebrate.

The anterior extremity of the centrum of the cervical vertebra is prominently convex, and much depressed. The posterior and concave extremity is wider, and of rather greater vertical diameter. The base of the neural arch only occupies half of the length of the centrum, an equal extent of the superior surface extending freely beyond it at its anterior and posterior extremities.

The linear lateral foramen commences a little behind the anterior base of the neural arch, and descending somewhat in its direction, terminates beneath the posterior extremity of the base of the neural arch. The base of the latter overhangs the foramen and the base of the transverse process. The interior surface of the centrum is concave, the concavity being bounded in front by the inferior convex thickening of the extremity. Behind the middle the surface becomes plane, and is, near the posterior extremity, bounded on each side by a short angular ridge.

Measurements.	M.
Length of centrum between anterior convexity and posterior lip	.565
Depth of posterior cup	.090
Diameter of cup { vertical	.310
Diameter of cup { transverse	.160
Length of parapophysis	.095
Width of neural canal	.063

The dorsal vertebra which I suppose the anterior one of those received, is characterized by the lack of the median portion of the neural spine, and the extension outwards of the median lateral processes described above. The diapophyses are much longer, and the zygapophyses more extended transversely. The centrum is constricted at the middle, and especially just behind the convex articular extremity, whose circumference forms a prominent rim. The edges of the lip are flared outwards, forming a deep basin, much wider than deep. The fossæ described in other vertebræ are present in this one, but differs in proportions, owing to the greater size and expanse of the superior parts of the neural arch. The fossa posterior to the base of the diapophysis is nearly plane, while that at the anterior base is deeply excavated, is narrower, and extends so far along the inferior side of the process as to give it a semi-circular section near the middle. Distally the diapophysis has a trialate section, owing to its three longitudinal ridges, and the articular extremity is large and antero-posterior in direction. The process differs from that of the vertebra next described, in the possession of a facet near the middle of its anterior inferior bounding ridge, which is probably costal, as in the vertebra of *Crocodilia*. The lateral foramen of the centrum is subround. The general surface is smooth.

Measurements.	M.
Total elevation of vertebra	.770
" transverse extent of diapophyses	1.010
Diameter of centrum { longitudinal	.300
Diameter of centrum { vertical of cup	.250
Diameter of centrum { transverse of cup	.340
Diameter of centrum { " at middle	.205
Elevation of zygapophysis above centrum	.310
Diameter of zygapophysis { transverse	.170
Diameter of zygapophysis { antero-posterior	.090
Width of neural canal	.085
Transverse extent of neural spine	.440
Length of diapophysis from posterior zygapophysis	320
Antero-posterior width of end of diapophysis	.135

A dorsal vertebra from a more posterior position, is characterized by its undivivided transverse neural spine. The entire neural arch is of enormous elevation, but as the zygapophyses are above its middle, the neural spine is not as long relatively as in various other genera or as in the

caudals of this one. The sides of the centrum are strongly concave, and the borders of the cup flaring. The neural arch is everywhere excavated, so as to reduce the bulk, and produce lightness so far as consistent with strength. The diapophysis rises from a point above the neural canal. It sends a narrow ridge down to the sides of the latter, on each side of which its shaft and base are deeply excavated. The posterior of these fossæ is overlooked by the wide zygapophysis ; and the roof of the anterior one supports the anterior zygapophysis. The former are separated by another and vertical septum, which bifurcates below, forming two prominent borders of the neural canal. At each side of the base of the neural canal there are two trilateral fossæ, of which the anterior is much the larger and extends higher upon the lateral edge of the spine, They are separated by a lamina. The diapophysis is not very long, and is subtriangular in section near the extremity. The neural spine is thickened at the extremity as though for the attachment of a huge ligament, At the summit of its posterior basal fossa, at the middle of its height, is an outwardly curved process with a smooth extero-superior face.

Measurements.	M.
Length of centrum	.275
Total elevation of vertebra	.830
Elevation to posterior zygapophyses	.550
" of superior edge of diapophysis above centrum	.350
" " neural spine above posterior zygapophyses	.295
Length of diapophysis behind	.215
Depth of extremity of do. (restored)	.075
Transverse extent of summit of neural spine	.215
" " neural spine at middle	.330

In a dorsal vertebra from a more posterior position, the centrum is larger. The capitular costal articulation occupies a lower position, its inferior edge being in line with summit of the neural canal. The lamina which supports it is separated from the anterior lamina which is at the base of the diapophysis, by a deep cavernous sinus. The posterior zygapophyses send upwards to the broad neural spine a median buttress each, which enclose a fossa with the marginal buttress of the same. The hyposphen is represented by a vertical lamina only.

	M.
Total elevation of vertebra	.900
Elevation of neural spine	.300
" " " distally	.280
Diameter posterior articular face of centrum	.360

A lumbar vertebra displays a greater expanse of the posterior articular extremity, which is expanded like a dish. The neural arch and transverse processes have a small fore and aft diameter, and the lateral caverns at the base of the diapophysis are obsolete. The pneumatic foramina are slightly higher than long. Posterior zygopophyses are wanting.

		M.
Diameter of centrum	vertical	.380
	transverse	.420
	antero-posterior	.170
Expanse of diapophyses		.590
Vertical extent of base of diapophysis to capitular surface		.200

A proximal caudal gives the following

Measurements.

		M.
Total elevation		.560
Diameter of centrum	antero-posterior	.170
	transverse	.245
	vertical	.245
Antero-posterior diameter of neural spine		.075
Elevation of the neural canal		.040
Diameter of median caudal	fore and aft	.180
	vertical	.200
	transverse	.192
Diameter of posterior caudal	fore and aft	.155
	vertical	.175
	transverse	.145

A distal caudal of the elongate type has the following dimensions :

		M.
Diameter of centrum	antero-posterior	.155
	transverse	.125
	vertical	.100

The long diameter of the basis of the transverse processes of the large anterior caudal vertebræ is directed obliquely upwards and forwards. The anterior faces of some of these centra are flat.

The length of the sacrum is M. 0.900 ; elevation of first sacral rest, 0.500.

The head of the femur is subround. One side of the shaft is damaged, so that the form of its section cannot be ascertained. The side of the inner condyle is quite flat, and without epicondylar rugosity.

Measurement of femur.

	M.
Length	1.820
Antero-posterior diameter of head	.310
" " " internal condyle	.450

The anterior and posterior edges of the scapula are thin. The posterior is slightly concave, with a slight projecting irregularity near the middle, and is then turned decidedly backwards, bounding the glenoid extremity. The glenoid face is concave, and longer than the coracoid suture. The anterior border is more strongly concave, the distal extremity being more expanded forwards. The sides of this extremity are slightly rugose with coarse grooves. The articular facets are pitted. A low keel extends along the external side of the mesoscapula.

Measurements.	M.
Total length	1.517
Width distally	.680
" at middle	.325
" at mesoscapula	.810
Length of glenoid face	.400

The articular extremity of the coracoid is recurved and very robust. The borders of the bone are thick and roughened.

Measurements of Coracoid.		M.
Diameter	extero-internal	.690
	antero-posterior	.560
	vertical proximally	.

Measurements of Metapodial.		M.
Diameter proximally	transverse	.160
	antero-posterior	.095
Diameter medially	transverse	.075
	antero-posterior	.120
Diameter distally	transverse	.210
	antero-posterior	.105
Length		.270

That this species was capable of and accustomed to progression on land is certain from the characters of the bones of the limbs and their supports above described. The extraordinary provision for lightening the weight of a portion of the skeleton has more than one significance. It must be borne in mind that the caudal vertebræ retain the solid character seen in those genera which stood habitually on their hind limbs. That the present species was herbivorous is suggested simply by its huge dimensions, and the natural difficulty of supplying it with animal food.

AMPHICŒLIAS Cope.

Paleontological Bulletin No. 27, p. 2, (Published December 10, 1877).

The genus to which the above name is now given, is allied to *Camarasaurus*, of which, and the gigantic species *C. supremus*, I have given an account in my Paleontological Bulletin, No. 25. Both genera differ from their nearest ally *Ornithopsis* Seeley, in the excavation of the vertebral centra, so as to include large chambers separated by a septum, which communicate with the external medium by a lateral foramen. In the *Ornithopsis* it is stated that the vertebral centra are occupied by a number of coarse cells. In the more remotely allied *Cetiosaurus*, Owen has observed that the tissue of the centra is coarsely spongy.

The vertebræ from all parts of the column of *Camarasaurus* are known, and those of the dorsal and lumbar regions present the extraordinary character, of which a trace is seen in *Cetiosaurus*, of neural spines expanded transversely to the axis of the column. Numerous vetebræ of *Amphicœlias* are known, and in the dorsals in which the neural spine is preserved,

the latter displays the usual form, that is, it is compressed in the direction of the axis of the column. The centra differ from those of *Camarasaurus* in the form of their articular extremities, resembling more nearly in this respect the genus *Tichosteus* Cope (Paleontological Bulletin, No. 26, p. 194). They are unequally amphicœlous, the posterior extremity being more concave, and with prominent margins; while the opposite one is less expanded and is but slightly concave. The neural arch is coössified to the centrum, and there is no capitular costal articulation on the latter.

The manner of the mutual articulation of the neural arches in this genus is peculiar, and is only paralleled in the genus *Camarasaurus*, so far as I can ascertain. The anterior zygapophyses are separated by a deep fissure, while the posterior zygapophyses are united on the middle line. From the latter from the point of junction, there descends a vertical plate which rapidly expands laterally, forming a wedge whose base looks downward. The supero-lateral faces are flat, and articulate with corresponding facets on the inferior side of the anterior zygapophyses, which look downward and inward, on each side of the fissure above described. When in relation, the anterior zygapophyses occupy a position between the posterior zygapophyses above, and the *hyposphen*, as I have termed the inferior reversed wedge, below. This arrangement accomplishes the purpose effected by the zygosphenal articulation, that is the strengthening of the articulation between the neural arches, but in a different way. The additional articulation is placed at the opposite extremity of the vertebra, and it is the anterior zygapophysis instead of the posterior one which is embraced. This structure entitles the genera which possess it to family rank, and as the two genera mentioned above belong to different families in consequence of the different types of vertebral centra, the one opisthocœlous, the other amphicœlous, they may be called *Camarasauridæ* and *Amphicœliidæ* respectively.

The pubis is a stout bone with one slightly concave, thicker border, and an opposite strongly convex, thinner margin. One extremity is truncate; the other presents one transversely truncate and one oblique face. The femur is elongate, and presents a strong postero-external ridge or third trochanter near the middle of the shaft. The head is not separated by a well marked neck, and the great trochanter does not project beyond it.

Thus while there is a striking resemblance to *Camarasaurus* in what may be regarded as adaptive characters, in some important essentials the two genera are very different.

AMPHICŒLIAS ALTUS Cope.

Paleontological Bulletin, No. 27, p. 3.

The centrum of the dorsal vertebra of this reptile is contracted both laterally and inferiorly, so that the margins of the articular extremities flare outwards. The sides are flat, and the inferior surface but little convex in the transverse direction. The pneumatic foramen is situated at the bottom of a large lateral fossa which extends nearly the entire length of the superior

portion of the centrum. Its inferior border is sunken abruptly, while the superior gradually shallows on the external surface of the base of the neural arch. The foramen is longer than high, in contradistinction to that of the *Camarasaurus supremus*, where it is round or higher than long.

The neural arch is very much elevated to the zygapophyses. It is strengthened by a prominent rib, which extends from the posterior base upwards and forwards to the base of the anterior zygapophysis. The surface above and behind this is occupied by an extensive excavation whose superior border is the line connecting the zygapophyses. The anterior zygapophyses are separated medially by a deep notch which extends to the base of the neural spine. The articular surfaces incline towards each other. Just behind the anterior zygapophysis, a process extends outwards and forwards whose extremity is lost in my specimen. Its posterior face is excavated by the lateral fossa above described. This process is probably the diapophysis which supports the rib. The diapophysis springs from the line connecting the zygapophyses, and extends upwards and outwards. Its inferior surface is deeply excavated. Its anterior border sends a lamina upwards, which probably reached the side of the neural spine, but is broken off in my specimen.

The neural spine is thin, but its anterior and posterior borders are thickened and double, the lateral rib-like edges being separated by grooves which expand at the base. The posterior groove continues to a more elevated point than the posterior. Each side of the spine is divided into two shallow wide grooves by a median keel. The apex of the spine is much thickened transversely, its obtuse extremity having the fore and aft and transverse diameters equal.

The pubic bone resembles that of the *Camarasaurus supremus*, but is less robust in all its parts. It is also less extended in antero-posterior width near the proximal extremity.

The femur is remarkable for its slender form. It is a few inches longer than that of the *Camarasaurus supremus*, but is not so robust. The shaft is nearly round and somewhat contracted at the middle, where it is slightly convex backwards. It is slightly curved inwards at the great trochanter. Here the shaft is moderately grooved on the posterior face. This trochanter is only a prominent ledge below the head. The third trochanter is situated a little above the middle of the shaft; it is a prominent obtuse ridge directed backwards. The condyles are extended well posteriorly, and are separated by a deep popliteal groove, which originates on the inferior portion of the shaft. They are also separated anteriorly by a shallow open groove. The external condyle is rather more robust than the internal.

The length of the femur is six feet four inches; the elevation of the dorsal vertebra three feet three inches.

Measurements.		M.
Diameter of dorsal centrum	fore and aft	.245
	vertical	.270
	transverse	.265

Total elevation of vertebra		1.100
Length of neural spine		.600
Elevation of anterior zygapophyses		.500
Diameter of neural spine	antero-posterior	.160
	transverse (at middle)	.065
	" at summit	.140
Depth of centrum below pneumatic foramen		.120
Fore and aft diameter of pneumatic foramen		.080
Length of pubic bone		1.060
Thickness of stoutest extremity		.140
Length of femur		1.524
Transverse extent of proximal end		.420
" " " condyles		.320
Diameter of middle of shaft		.220
Distance from head to third trochanter		.665
Diameter of head (compressed)		.260

Amphicœlias latus Cope.

Paleontological Bulletin, No. 27, p. 4.

Of the wonderful fauna of the Dakota epoch of the Rocky Mountains the *Camarasaurus supremus* was preëminent in general proportions, the *Amphicœlias altus* was the tallest, and the saurian now to be described, was the most robust. It is represented in Mr. Lucas' collection by a right femur and four caudal vertebræ which are in good preservation. They reveal the existence of another saurian of huge dimensions, and of great mass in proportion to its height.

The caudal vertebræ are apparently from the anterior part of the series. They are all strongly bi-concave ; the anterior face more so than the posterior. They all possess diapophyses of depressed form, which take their origin below the base of the neural arch. The centra are short in antero-posterior diameter, and do not present lateral angles. They are composed of not very dense osseous tissue. The anterior zygapophyses are rather elongate, and their articular faces are directed steeply inwards. They are received by corresponding shallow excavations, one on each side of the posterior base of the neural spine. The neural spines are compressed and straight, and become very robust towards the apex.

The femur is extraordinarily robust. The great trochanter is low, but the shaft is widest where it expands outward. The third trochanter is a ridge, is above the middle, and is short and little prominent. It is on the inner edge of the posterior aspect of the shaft, and looks backwards and inwards. The shaft in its present state is compressed so as to reduce the antero-posterior diameter. It is not however crushed or cracked. The condyles have much greater transverse than antero-posterior extent. They are moderately produced backward, and are separated by a deep inter-condylar groove, while the anterior trochlear groove is wide and well marked. The inner condyle is narrowed posteriorly, while the external one is obtuse and robust.

The articular extremity is marked with irregular pits as in *Dystrophœus* and *Cetiosaurus.*

Measurements.		M.
Diameter of anterior caudal vertebra.	fore and aft...	.150
	vertical.......	.200
	transverse......	.260
Elevation to zygapophyses of the same..............		.250
Total elevation of the same........................		.480
Length of femur....................................		1.400
Proximal diameter of femur	fore and aft............	.165
	transverse	.410
Distal diameter of femur	fore and aft................	.360
	transverse.................	.450
Diameter of middle of shaft of femur................		.280

The caudal vertebræ of this species are much more deeply biconcave than those of the *Camarasaurus supremus;* they also differ in their relatively and absolutely greater breadth of centrum.

TICHOSTEUS Cope.

Paleontological Bulletin No. 26, p. 194, (Published November 21st, 1877.)

Tichosteus lucasanus Cope.

Loc. cit.

SYMPHYROPHUS Cope.

Vertebral centra moderately elongate, slightly amphicœlous, and composed of uniformly and moderately dense osseous tissue. A narrow deep fossa in the floor of the neural canal. Neural arch coösified to centrum, with a lateral shallow fossa at its base. Neither costal articulation nor process on the centrum.

The coösification of the neural arch of this genus distinguishes it from the few amphicœlous crocodilian genera known from North America, and the fossa at its base is so shallow as to separate it from sauria of the *Pneumatarthrus* and *Ornithopsis* type.

Symphyrophus musculosus Cope.

A vertebra of this species is strongly concave laterally and distinctly so inferiorly. The anterior articular facets plane, the posterior slightly concave. The superficial layer of bone is dense and smooth, excepting near the edges of the articular surfaces, where it is rugose. The rugosity is arranged in a line within the articular faces, and consists of numerous small irregular pits and grooves which inosculate. Near the border the grooves assume a transverse direction. There is a nutritive foramen near the middle of each side of the centrum. There are traces of the neurapophysial suture, showing that the neural arch is distinct in young animals.

Measurements		M.
Diameter of centrum	antero-posterior................	.032
	vertical........................	.027
	transverse......................	.031

The extremity of a humerus is expanded transversely and displays two unequal condyles, separated by a shallow groove. There are no epicondyles on the external face, but fossæ instead.

Measurements.	M.
Width of distal extremity of humerus	.086
Antero-posterior diameter of larger condyle of the same.	.045

Discovered by Superintendent Lucas near Canyon City, Colorado.

LAELAPS. Cope.

Transac. Amer. Philos. Soc. XIV, 1869, p. 100.

Laelaps trihedrodon. Cope.

Bulletin U. S. Geol Survey, Terrs. III, p. 805, August 15, 1877.

CAULODON. Cope.

Paleontological Bulletin, No. 26, p. 193, Nov. 21st, 1877.

Caulodon diversidens. Cope.

Loc. cit.

Caulodon leptoganus. Cope.

A second species of the genus *Caulodon* is represented by a single tooth from a locality distant from that from which the *C. diversidens* was derived. Another tooth found with it probably belongs to the same species.

The best preserved tooth possesses the same general form as that of the *C. diversidens*, but the borders of the spoon-shaped crown are thinner and more acute. The convexity of the convex face of the crown does not commence at these edges, but is separated from them by an open shallow groove. There is a median longitudinal swelling at the middle of the length of the concave face. The striking peculiarity of this species is the very small amount of enamel which invests the crown. It is confined to the inner face, and exists there in a thin layer, not more than half as thick as in the *C. diversidens*, which thins out and disappears towards the edges of the crown. Another peculiarity is seen in its absolute smoothness. In *C. diversidens* the enamel, even when polished by use, shows remains of the grooves.

Measurements.		M.
Diameter of crown at base	fore and aft	.015
	transverse	.019
Diameter of crown at middle	fore and aft	.010
	transverse	.021

Found by Superintendent Lucas near Canyon City, Colorado.

COMPSEMYS. Leidy.

Compsemys plicatulus Cope.

Paleontological Bulletin, No. 26, p. 195.

Explanations of the figures will be found at the end of this volume.

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PALEONTOLOGICAL BULLETIN, NO. 29.

DESCRIPTIONS

OF

Extinct Batrachia and Reptilia

FROM THE PERMIAN FORMATION OF TEXAS.

By E. D. COPE.

(*Read before the American Philosophical Society, April 5th,* 1878.)

Descriptions of Extinct Batrachia and Reptilia from the Permian formation of Texas.

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(*Read before the American Philosophical Society, April* 5, 1878.)

REPTILIA.

DIADECTES SIDEROPELICUS. Gen. et. sp. nov.

Char. Gen. Teeth with short and much compressed crowns, whose long axis is transverse to that of the jaws. Edges of the crowns obtuse, with tuberosities on some of them, distinct from the principal apex. The latter is worn off very obliquely by attrition in all of the specimens. The crowns covered with an enamel-like substance which has no especial sculpture. Alveoli not separated. The external alveolar border in each jaw is more elevated than the internal, and in the superior series at least, diverges from the tooth-line backwards and outwards. The surface of attrition descends outwards in the maxillary series, and rises inwards in the dentary series. A large fossa pierces the inner alveolar border just behind the inner extremity of each tooth.

The affinities of this very singular form cannot yet be determined. The mandibular ramus rises directly from the posterior extremity of the dental series, showing that there is a coronoid elevation of the dentary bone as in *Dinosauria*. The teeth are received into deep alveoli. It is probable that the vertebræ are amphicœlous. The animals belonging to this genus were, in all probability, herbivorous.

Char. Specif. The jaws, and probably other bones of three individuals of this species, represent it in my collection. The lateral tuberosity of the teeth already described is on the most elevated, hence opposite, borders of the crowns in the two jaws. It differs in its degree of prominence in different teeth, but is subject to attrition in one of the jaws at least. The form of the principal worn surface is an elongate oval. The investing layer of the crown is perfectly smooth, excepting between the lesser and greater cusps, where the obtuse edge is slightly longitudinally grooved. The surface of the jaws is not sculptured.

Measurements.		M.
Greatest elevation of a tooth (No. 1)		.011
Diameters of crown	transverse	.006
	antero-posterior	.012
Four teeth occupy		.042
Four alveoli of No. 2, occupy		.024

The jaws are as large as those of a medium-sized alligator.

DIADECTES LATIBUCCATUS. Sp. nov.

The anterior portion of a probably maxillary bone represents this species. On comparison with the corresponding portion of the jaw of *D. side-*

ropelicus, the following characteristic marks appear: The tooth-line diverges much more strongly inwards from the maxillary border in the *D. latibuccatus*, leaving a wide groove between the two. This groove is separated by a narrow horizontal partition from a corresponding one of the superior face of the same element, and its surface is longitudinally roughened. The teeth are closely placed, and the series turns with the anterior extremity of the jaw, abruptly inwards. The transverse diameter of the teeth lessens to just posterior to the point of curvature, so that their section is nearly round; at and anterior to the curve, the wide transverse diameter is resumed, the last alveolus preserved making an angle of 45° with those in the posterior part of the jaw. The external surface of the maxillary bone is roughened, as is also the case in the *D. sideropelicus*, with coarser and finer irregular impressions, fossæ and grooves.

Measurements.	M.
Width of jaw at ninth tooth from curve	.036
Width of ninth tooth from curve	.011
" " fourth " " "	.006
" " tooth at curve	.008
" " third tooth anterior to curve	.010
" " jaw at curve	.019
Elevation of alveolar part of jaw	.018
Three teeth in	.015

There are other fragments of jaws referable to *Diadectes* whose specific reference is uncertain.

Bolosaurus striatus. Gen. et. sp. nov.

Char. Gen. Teeth fixed in shallow alveoli, and with the crowns expanded transversely to the axis of the jaws. The crowns swollen at the base, and with low apex, divided vertically into two equal portions. The postero-internal half in the maxillary series is low and horizontal; the antero-external portion forms a curved cusp, which has a semicircular section. The teeth of the lower jaw are similar, but the relative positions of the ledge and cusp are reversed. Anterior teeth of superior series composed of external cusp and internal ledge. No enlarged canine or incisor teeth. Bones of face not sculptured.

This genus is represented by a good many remains, which include some partially complete crania. These show that there is no quadratojugal arch, and that the quadrate is of the flat character of that of the *Anomodontia*, and was probably immovable. The orbit is complete behind, and there is a strong squamosal arch. The vertebræ are amphicoelous, and probably notochordal. The neural arches are freely articulated with the centrum, and the zygapophyses and neural spine are well developed.

The vertebræ resemble those of *Lysorophus** (Cope) from the Illinois Permian, but they do not display the deep longitudinal fossæ of that genus.

* Proceed. Amer. Philos. Soc. 1877, p. 187.

Char. Specif. The external surface of the crown is marked to the apex with waved grooves of the enamel. The edge of the elevated cusp, which presents posteriorly in the maxillary teeth, constitutes the abrupt termination of the exterior face, and is serrate by the interference of the sulci. The edge of the basal ledge is slightly serrate. The muzzle is rather elongate, and the sides of the maxillary and dentary bones are plane and smooth. The mandible is rather narrow, and forms a narrow wedge in profile outline. It rises posteriorly behind the dental line. The teeth are separated by intervals as wide as a tooth.

Measurements.	M.
Long diameter of orbit No. 1	.0130
Depth of upper jaw at orbit	.0045
" lower jaw at front of orbit	.0050
Four teeth in	.0080
Elevation of a crown	.0025
Transverse diameter of inferior molar No. 2	0025

From the same locality as the *Diadectes sideropelicus.*

A slight modification of character is found in two imperfect crania. The principal character is to be seen in the teeth. The enamel of the external surface of the cusp is not sulcate, but is smooth ; and the posterior cutting edge of the cusp is much less distinct. It is, in fact, obtuse, and not serrate. The orbit is large, and the front and muzzle are regularly decurved to the premaxillary border. The angle of the mandible is moderately prominent, and is massive and obtusely truncate. The interorbital region is flat in the transverse direction.

Measurements.	M.
Length of skull to mandibular angle	.050
" " orbit	.015
Long diameter of orbit	.018
Width of interorbital region	.009
Six teeth in	010

BOLOSAURUS RAPIDENS. Sp. nov.

Established primarily on a tooth from the posterior or middle portion of the series, with which is associated another, probably from an anterior position in the jaw. The size is many times greater than that of the species of this genus already described, and it is uncertain whether the posterior tooth possesses the internal ledge characteristic of them. The anterior tooth does not possess it. The transverse diameter of the crown is considerably greater than the antero-posterior, and the convexity of the outer side is without facets. One side of the curve is flatter than the other. The enamel is perfectly smooth. The inner face is occupied by the surface of attrition of the corresponding tooth of the opposite jaw. The supposed anterior tooth is from anothor locality. Its section is similar to that of the present tooth, and the enamel is similarly smooth. The cutting edges are both smooth, and bounded by a little groove next the plane inner face. The

crown is much more elevated than that of the tooth first described, and is in general shaped like a claw. It may be from the pterygoid bone of another genus.

Measurements.		M.
Elevation of crown (axial)		.010
Diameter of crown	antero-posterior	.006
	transverse	.008

PARIOTICHUS BRACHYOPS. Gen. et. sp. nov.

Char. Gen. This form is represented by a cranium which has lost its superficial osseous stratum at some points, and the entire occipital region. The temporal fossæ were covered by a roof continuous with the postorbital region ; the zygomatic arch extends low down, producing a resemblance to certain tortoises. The orbits are small and lateral, and the muzzle is short, with terminal nares. Their exact character cannot be ascertained. The teeth are rooted, and have compressed obtuse crowns, with cutting edge ; they diminish in length posteriorly, and do not display any elongate canine. The cranial bones do not exhibit any sculpture.

This genus is quite distinct from the others here described from corresponding parts of the skeleton. In the constitution of the skull it resembles Prof. Owen's genus *Kisticephalus* from supposed Triassic beds of South Africa, but differs totally in dentition.

Char. Specif. The interorbital width is twice the diameter of an orbit, and is nearly flat. The cheeks behind the orbits are swollen ; the canthus rostralis is obtuse. The muzzle is obtuse, broadly rounded, and somewhat depressed ; the nostrils were not large. The orbits are subround, and measure one half of the length of the muzzle measured axially above. The mandibular rami are not deep. The longest teeth are below and in front of the anterior border of the orbit; posterior to this point they diminish rapidly, and are reduced to a very small size. The crowns of the greater number of the teeth are short and much compressed, and the enamel is coarsely longitudinally grooved. An anterior mandibular tooth has a subconic crown.

Measurements.	M.
Width of skull at parietal region	.020
Length " from "	.022
Interorbital width	.010
Four teeth in	.004
Length of root and crown of a tooth	.002

From the locality of the last species.

ECTOCYNODON ORDINATUS. Gen. et sp. nov.

Char. Gen. Cranium short and wide, with large post-frontal bones and a large orbit. Cranial bones sculptured, but no lyra. Teeth rhizodont, with elongate compressed crowns with anterior and posterior cutting edges. One of these between the orbit and nostril larger and longer than the others, and lying outside of the closed dentary bone. Mandibular

symphysis not sutural, but ligamentous. Terminal mandibular tooth not small. Teeth not faceted, simple.

This genus, which I suppose to be reptilian, is represented by a specimen which lacks the posterior portion of the skull; hence its near affinities cannot be determined. In the character of the cranial sculpture it resembles crocodiles, and the Labyrinthodont genera cotemporary with it, and differs from *Lacertilia* with cranial sculpture known to me.

Char. Specif. Parietal and frontal regions flat, the latter joined to the maxillary by a rectangular canthus. Interorbital region wide, equal to the diameter of the orbit. Sculpture of vertex in longitudinal series of pits of considerable irregularity. There are ten or twelve such rows between the orbits. The crowns of the teeth are obtuse, and their surface smooth.

Measurements.	M.
Interorbital width of skull	.009
Width between prefrontal borders	.014
Depth of facial plate of maxillary	.007
" ramus mandibuli at orbit	.006
" " " near end	.003
Length of short maxillary tooth	.0015
" long " "	.0030
Width " " "	.0015

The skull of this species is about as large as that of the *Heloderma suspectum.*

CLEPSYDROPS NATALIS. Sp. nov.

This reptile is represented by numerous portions of the skeleton, including a cranium, and thus offers the best basis of information as to the character of the genus *Clepsydrops* which has yet come into our hands. This furnishes numerous interesting characters, which as found in a single individual furnish a basis of estimation for the entire group.

Char. Gen., et cætera. There is no quadratojugal arch, but the zygomatic and postorbital arches are present. The squamosal extremity of the zygomatic arch descends low on the quadrate as in turtles, preventing mobility of the latter. The quadrate is not prominent in the specimen, and appears to have been a thin bone, as in *Ectocynodon.* The nostril is large and latero-anterior. The symphysis of the mandible is short, and the premaxillary bones appear to be distinct; they are separated in the specimen by displacement, with the indication that the junction was sutural. The teeth were of different sizes, and the premaxillaries and canines are distinguished from the others by their proportions. All are sub-round in section, with more or less defined anterior and posterior cutting edges. The premaxillary teeth are larger anteriorly, diminish posteriorly, and are separated by a notched diastema from the large canine. The succeeding teeth are of medium proportions. The roots are sunk in deep alveoli. There is no surface sculpture of the cranial bones, which is the character distinguishing the genus *Ectocynodon* from *Clepsydrops.*

The vertebræ have been described elsewhere, but important additions to our knowledge can now be made. There are mostly small intercentra throughout the dorsal and caudal series, in the latter prolonged into two processes below, constituting chevron bones. The transverse processes on the dorsal and lumbar vertebræ are undivided, and on some of the dorsals, the ribs articulate with the centrum as well. They are present on the anterior but wanting on the posterior caudal vertebræ. In adults the neural arch is coössified with the centrum, and on the lumbar and sacral region the neural spines are greatly elevated, indicating the presence of a fin like that of *Basiliscus*. In one of the allied species the diapophyses of three vertebræ are vertically expanded for the attachment of the ilium, but the centra are not coössified.

The humerus in this genus is of remarkable character. Its proximal extremity is expanded and regularly convex, with the articular surface at right angles to the sides of the bone, and not developing a head. There is a strong deltoid ridge or tuberosity, not extending far from the head. The shaft is much contracted, and the distal end is more expanded than the proximal. It is flattened, and supports no condyle. Its outline is transverse at the middle and truncate at each lateral extremity. A large supracondylar foramen pierces the basal part of the distal expansion near the inner border. The opposite edge is strongly grooved longitudinally, the groove being bounded in front by a prominent crest, which sinks just proximad of the distal border.

The ilium is a flat bone which contracts downwards and forwards to the pubis. The latter is something like the ilium in form, widening in the opposite direction, *i. e.* downwards and forwards. Its form is something like that of the *Crocodilia*, and it is uncertain whether those of opposite sides unite below. The ischium is a remarkable bone. It is greatly produced anteriorly and posteriorly to the acetabulum, in forming with that of the opposite side, a keeled boat-shaped body, which at its superior middle portion includes the inferior part of the acetabulum. In *C. natalis*, the anterior apex is below the middle line of the pubes near their anterior border. In the same species there is an additional small element between the ilium and pubis on the superior side at their junction. The acetabulum is formed by the interrupted junction of the three elements.

The femur possesses no third trochanter, and the head and great trochanter are not separated by a neck. The little trochanter is large, and the condyles are well defined. The head of the tibia is expanded, and the fibula is well developed at both extremities. The phalanges are moderately elongate, and are depressed. The claws are curved and compressed below.

The various remains of this genus now in my possession, and especially the skeleton of *C. natalis*, show that the determinations of various parts of the skeleton made from isolated fragments from Illinois, were correct.

Of the general affinities of this genus it is only necessary now to state that my reference of it to the *Rhynchocephalia* is confirmed. It differs

from the recent species of the order in the absence of quadrato-jugal arch, and the remarkably developed ischia. On this account I refer to *Clepsydrops* and its allies as a distinct suborder under the name of *Pelycosauria*.

Char. Specif. The muzzle of this species is compressed and descends obtusely at the end as in *Bolosaurus striatus*. The nostril and orbit are quite large. The first premaxillary tooth is the largest and has a silky striation of the enamel; its crown is much less than that of the canine. The canine originates below a point a short distance posterior to the nostril.

Measurements.	M.
Length of skull to posterior base of quadrate	0.124
Diameter of nostril	.019
Depth of zygoma at orbit	.012
Length of crown of canine tooth	.016
Antero-posterior diameter of canine tooth	.005

The centra of the lumbar vertebræ are compressed, but not deeper than long, nor acute on the median line below. The diapophyses are wide, and descend towards the anterior articular border. The neural spines are compressed, and are very long. Their apices are slender and curved backwards. The faces of the zygapophyses are oblique upwards and outwards. The caudal vertebræ have subround articular extremities anteriorly, and become more compressed posteriorly. The diapophyses are median on the former, and gradually become smaller to extinction. The zygapophyses are strong, and the neural spines continue long for a considerable part of the length of the entire series. The centrum is concave below the diapophyses, and has a median inferior rib.

Measurements.	M.
Length of centrum of fourth from last lumbar vertebræ	.018
Vertical diameter of " " "	.017
Transverse diameter of " " "	.018
Elevation of neural arch and spine of last lumbar	.087
Antero-posterior extent of ilium	.059
" " " " pubis	.060
" " " " ischium	.143
Depth of pelvis	.080
Length of femur	.120
Long diameter of proximal end	.041
Length of tibia	.085
Transverse width of tibia	.029
Length of eleven caudal vertebræ	.172
" " fourth caudal "	.016
" " eleventh caudal "	.014
Transverse diameter of caudal	.012

This species differs from the *C. vinslovii* in the more robust caudal vertebræ. It is also considerably larger, agreeing in this respect with the *C. pedunculatus*. In the latter the long transverse processes are decurved

and narrowed at the extremities in a manner not seen in any of the known vertebræ of *C. natalis*.

DIMETRODON INCISIVUS. Gen. et sp. nov.

Char. Gen. Dentition as in *Clepsydrops* in the superior series. Pubic bone not distinct from ischium. Humerus with trochlear condyles and a defined proximal articular surface.

The genus *Dimetrodon* embraces larger forms than the known species of *Clepsydrops*. It is probable that the species had the neural spines in the lumbar and dorsal regions elevated in the same way. The humerus while of the same general character as that of *Clepsydrops*, differs remarkably in its more perfect articular surfaces, indicating a terrestrial habit as distinguished from a probably aquatic one in the former genus. The supracondylar foramen is present in this genus, and the proximal articular surface winds obliquely round the expanded extremity of the bone.

The separate jaws of *D. incisivus* show well the character of the dental insertions. A strong thickening of the inner wall of the maxillary bone is all that represents the palatine lamina. This enlargement does not extend to the level of the external alveolar margin, which thus forms a parapet. The roots of the teeth are long, and are contained in deep alveoli of the palatine thickening; but the portion of them which projects beyond the alveoli is adherent to the external parapet by the side, and hence the teeth appear to be pleurodont. They are shed in after the absorption of the root in consequence of the presence of the crown of the successional tooth. The process commences at the inner alveolar border, and extends inwards and upwards invading the palatine wall of the maxillary bone.

Dimetrodon is allied to *Deuterosaurus* Eichw. and *Eurosaurus* Fisch. as defined by Meyer, the former known from a portion of the cranium, the latter from bones of the skeleton. From the former it differs in the persistence of the sutures separating the elements of the jaws, supposing the figure reproduced by Owen (Quar. Journ. Geol. Society, 1876, p. 358) to be correct in the omission of them. Apart from this, *Deuterosaurus* has much more elevated nostrils, more numerous incisor teeth, and wants the extensive diastema in front of the superior canine. *Lycosaurus* Ow. from the South African Trias resembles it much more nearly, but does not present the greatly enlarged anterior incisor teeth of *Dimetrodon*.

Char. Specif. This saurian is established on the nearly complete premaxillary and maxillary bones of the right side with the left maxillary of the same individual. Associated with these are portions of the post-frontal, frontal and nasal bones of the right side of perhaps the same individual, but as the pieces are loose, this relation cannot be positively affirmed. Portions of the maxillary, premaxillary and other bones, with isolated teeth of numerous other individuals are in my possession.

The first named specimens show that the mutual premaxillary and premaxillo maxillary sutures are distinct. There is a deep emargination of the border of the jaw at the latter suture, and the maxillary alveolar bor-

ders is gently convex downwards. The nostril is large, and is directed forwards as well as outwards: the premaxillary spines are narrow. The form of the muzzle and jaws when in normal relation was vertical and compressed in front. The premaxillary border of the jaw is rounded and contracted behind the nostril; the outline then expands backwards. There are but two incisor teeth, of which the anterior is much larger than the second. Its root is irregular in section owing to the presence of one or more shallow longitudinal grooves. The pulp cavity of some of the larger teeth is much contracted opposite these grooves by the corresponding internal face, which is disproportionately convex. The anterior two teeth of the maxillary bone are larger than those that follow, the anterior exceeding even the first incisor. The other maxillaries are smaller and sub-equal, excepting the last two, which are the smallest. The crowns of the teeth are lenticular in transverse section, the external side being much more convex than the internal. The cutting edges are defined from the convexity of the latter by a shallow groove at the base of each. The edge is not crenate as in *Lælaps* and allied genera, but presents much the same appearance owing to the presence of a transverse corrugation. There are fourteen teeth and empty alveoli in the maxillary bone.

Measurements.	M.
Length of premaxillary axially, to middle of maxillary suture	.040
Length of maxillary bone on alveolar edge from middle of premax. suture	.230
Greatest width of premaxillary	.036
Depth of face of premaxillary bone at nostril	.030
Length of diastema (chord)	.032
Depth of maxillary at third tooth	.110
" " antepenultimate tooth	.066
Diameter of base of crown of first incisor tooth	.015
" first maxillary tooth	.018
" fourth " "	.009

The portion of cranium above mentioned displays a number of peculiarities. The orbit is lateral, and has a prominent and convex superciliary border. The zygomatic arch is so curved upwards as to complete the orbit behind by the intervention of a postorbital or postfrontal bone, which separates the malar and squamosal bones from mutual contact. In front of this bone a portion of the frontal forms the superciliary border, and in front of this, the prefrontal sends a wide process behind the lachrymal to the orbit. This bone resembles a nasal bone in form, and extends forwards, and is decurved at the extremity. The width of the descending or malar process of the postfrontal is such as to partially separate the orbit from the zygomatic fossa. The superciliary surface is swollen, and is interrupted by a transverse groove on the orbital part of the prefrontal. There is a vertical open groove on the malar process of the postfrontal.

Several large pelvic bones corresponding with those which I have called

ischia in *Clepsydrops natalis,* are of a size appropriate to the present species. They include both the ilia, ischia and pubes in one mass, forming a compressed boat-shaped body with a prominent inferior keel.

The prominent character which distinguishes this species is the shortness of the ischiatic symphysis. Its extent anterior to the acetabulum is only one-half the diameter of the latter, while it equals that diameter in the *C. gigas.* It follows from this, that the crest arising from the anterior border of the acetabulum is abruptly decurved a little anterior to the latter, and descends to the inferior keel at a very steep angle. At its point of decurvature is a prominent tuberosity. The front of the symphysis pubis presents an obtuse keel, which terminates short of the apex. The inferior border of the acetabulum is not sharply defined, except at its posterior portion.

Measurements.	M.
Total length	.260
Length from posterior border of acetabulum forwards	.148
Long diameter of acetabulum	.095
Total vertical diameter to superior border of acetabulum	.135
Length of anterior symphysis	.085

From the same locality as the last species.

DIMETRODON RECTIFORMIS. Sp. nov.

This species is represented by portions of the vertebral columns of three individuals at least. Its size exceeds considerably that of the *Clepsydrops natalis,* equaling that of the *C.* (*? Embolophorus*) *limbatus* Cope. Of the latter species I possess numerous vertebræ, and they all differ in a marked manner from the present species.

In *Dimetrodon rectiformis,* the depth of the centra does not exceed the length. The margins of the articular faces are not twisted, and the articular faces of the zygapophyses are horizontal. The opposite is the case in the *C. limbatus.* The spaces for the intercentra are small; they are large in *C. limbatus.* The vertebra described as typical is a posterior dorsal. Here the diapophyses is nearly sessile, and below the line connecting the zygapophyses. Its costal articular surface is narrowed downwards and forwards, almost reaching the recurved border of the anterior face. The neural spine is much elevated, and the sides of the centrum are concave. The inferior articular borders are connected by an acute nearly horizontal edged keel.

Measurements.		M.
Diameter of centrum	antero-posterior	.031
	transverse	.034
	vertical	.026
Expanse of posterior zygapophyses		.030
Length of base of neural spine		.025

From the same region as the other species here described.

DIMETRODON GIGAS. Sp. nov.

Clepsydrops gigas. American Naturalist, May, 1878, p. 327.

This animal is only represented in my collection so far by a large part of the pelvis. This is of the same character as that of the *C. natalis*, but differs in several details of form and is three times as large in linear measurements. The portion anterior to the acetabulum is shorter than in the *C. natalis*, and relatively deeper. The raised borders of the acetabulum unite, and form a thick obtuse horizontal crest, which continues to the apex, which consists of a broadly expanded shovel-like projection. This symphyseal portion is quite elongate, and carries on its supero-anterior face an obtuse median keel. The opposed elements diverge above the anterior part of the acetabulum. The latter is shallow but entire; its most prominent borders are the anterior and postero-inferior.

Measurements.	M.
Length from posterior border of acetabulum forwards...	.200
Long diameter of acetabulum	.100
Total vertical diameter to superior border of acetabulum	.155
Length of anterior symphysis	.175

EPICORDYLUS ERYTHROLITICUS. Gen. et sp. nov.

Char. Gen. *Epicordylus* is known from a large part of the vertebral column, including all the regions excepting the cervical, so far as at present appears. In general the vertebræ resemble those of *Clepsydrops*, having well-developed intercentra. The diapophyses are at the base of the neural arch, and are prominent, and with large undivided articular extremity; they are not present on the caudal vertebræ. The neural spines are compressed below and enlarged transversely above, so as to be claviform. They are not elongated over the lumbar or sacral regions, but are similar to those of the dorsal vertebræ at those points. The *ossa ilii* resemble those of *Clepsydrops*. The zygapophyses are as usual oblique upwards and outwards, and the centra are not shortened.

Char. Specif. The centra are a little compressed, and higher than wide. In the anterior caudal region they are a good deal more compressed. The intercentra in a part of the dorsal series are larger than in any known species of *Clepsydrops*. The neural spines are bilobed at the apex on the sacral region, and become shortly bifurcate on the caudal series.

Measurments.	M.
Length of a series of seventeen dorsal vertebræ.........	.610
" an anterior neural spine....................	.050
" posterior................................	.070
" tubercular costal face of anterior dorsal.....	.020
" " " on seventh vertebræ of the series from the last..................	.035
" five caudal vertebræ of probably the same animal................................	.180
Elevation of fourth caudal neural spine................	.057

Width of neural spine at summit	.035
Length of ilium	.120

This species appears to have been about the size of the Mississippi alligator. Unfortunately the cranium is unknown, but probably some of the jaws and teeth in my possession belong to it.

From the region above already mentioned.

METARMOSARUUS FOSSATUS. Gen. et sp. nov.

Char. Gen. There are numerous vertebræ in the collection, from the median and anterior dorsal parts of the column, which differ from those of *Clepsydrops* and *Epicordylus* in their small antero-posterior diameter. That these all belong to one species, or even one genus, is not probable, in view of the many differences which they present. I select one of them whose characters are most strongly marked, and designate it as above, without deciding as yet, how many of the others which agree with it in some respects, may hereafter be associated with it as to species or genus.

The centrum is a good deal shorter than wide, and like those of all the other genera here described, is deeply biconcave. I have not yet ascertained whether it is notochordal, owing to the state of the specimens. The diapophyses project just below the base of the neural arch, and are short and with small tubercular facet. There is no capitular facet. The facet for the intercentrum is excavated at the anterior extremity of the base of the centrum and is quite small. The neural canal is rather large. The anterior zygapophyses have a peculiar form, their articular faces being directed downwards and outwards. This character, together with the form of the centrum and intercentrum, distinguishes this genus at once from those previously described.

Char. Specif. The posterior articular face is a little deeper than wide, and has rather thick recurved margins. The sides are concave, and the middle line below protuberant (in section), but not keeled. The intercentral fossa is a transversely oval pit well defined all round, and not interrupting the contour of the inferior margins of the articular faces.

Measurements.

		M.
Diameter of centrum	antero-posterior	.021
	transverse behind	.030
	vertical "	.030
	" in front	.024
Width of intercentral fossa		.010
Expanse of posterior zygapophyses		.025

About the size of the *Dimetrodon rectiformis*.

EMPEDOCLES ALATUS. Gen. et sp. nov.

Char. Gen. This genus is of the same type as those already described as allied to *Clepsydrops*. I know of it from numerous vertebræ, but few of which belong to any one individual, four consecutive centra being the largest number I have obtained in association. The various specimens

described, belong to the cervical and dorsal regions, and it is not unlikely that one series which is not yet extricated from the matrix, includes also lumbars, sacrals and caudals. But of the latter I am not at present able to give any account.

Both dorsal and cervical vertebræ possess centra of the general character of those of *Clepsydrops*, with small intercentra. The neural arches present important differences. There is on the posterior aspect, below the zygapophyses a well developed hyposphen, and on the anterior face a correspondingly strong hypantrum. The structure is identical with that which I have described as present in the genera *Camarasaurus* and *Amphicœlius*, but is rather better developed. It disappears at some posterior point of the dorsal series. The zygapophyses are much elevated and spread apart in *Empedocles*, and are connected together back to back. From this junction the diapophysis depends, forming a vertical septum whose inferior extent is greatest on the cervical, and least on the dorsal vertebræ. It is undivided, and as there is no capitular facet on the centrum, the rib had but a single head. The expansion of the diapophyses with that of the posterior zygapophyses gives to the posterior side of the vertebra a remarkable appearance, and forms an oblique roof above the centrum. The neural spine is not elevated, and is very robust, being in some cases greater in the transverse than the antero-posterior diameter, again approximating remotely *Camarasaurus*. Of the dentition nothing is known, but some jaws with teeth of animals allied to *Clepsydrops* may belong here. Probably other portions of the skeleton are in my possession, but I am unable as yet to correlate them.

Char. Specif. The diapophyses are not long, and their articular surfaces are quite elongate downwards and forwards, especially on the cervical centra. On more posterior dorsals the diapophysis arises exclusively from the neural arch, but maintains its very narrow oblique articular face. On all the vertebræ the centrum is about as long as wide, with regular marginal angles without bevel for intercentrum. The sides are concave, and the inferior median line horizontal, and thickened. The neural spine is short in the dorsals, and with a subquadrate section, with the angles lateral and antero-posterior. The apex is excavated at the extremity. The space between the planes of the opposite zygapophyses is strongly convex. The latter have horizontal faces. In other vertebræ the neural spine is more transverse, and the zygapophyses are separated on the median line by a smaller fossa on the anterior face of the arch, and a larger one on the posterior face.

In a specimen in which the hyposphen has disappeared, it is represented by a ridge connecting the posterior zygapophyses, which is decurved over the neural canal.

Measurements.	M.
No. 1, dorsal vertebra of smaller individual.	
Total elevation of vertebra	.105
Elevation of centrum	.029
" " zygapophyses	.060

Measurements.	M.
Elevation of base of neural spine	.083
Width of apex " " "	.025
Vertical extent of extremity of diapophysis	.036
Diameter of centrum { antero-posterior	.026
Diameter of centrum { transverse	.027
Width between inferior extremities of tubercular facets of diapophyses	.066
Width between extremities of zygapophyses	.082
Length " " " "	.042
No. 2, a larger individual.	
Total elevation	.130
Diameter of centrum { antero-posterior	.029
Diameter of centrum { transverse	.043
Diameter of centrum { vertical	.039
Extent of zygapophyses	.102
Elevation of neural spine	.026

The portions of the vertebral columns referred to this species cannot be reconciled with those of any of the species of *Epicordylus* or *Clepsydrops*. In both of these, large parts of the dorsal series are known, and even if those genera should possess dorsal vertebræ with hyposphen, which is very improbable, the peculiar forms of the zygapophyses and neural spine will still distinguish them widely.

Embolophorus fritillus. Gen. et sp. nov.

This form reposes on some dorsal vertebræ with intercentra and ribs in place, which display some interesting characters. The neural arch is coössified, and the zygapophyses and diapophyses are well developed; the latter not elongate, and standing on the base of the neural arch. The centra are notochordal. The intercentra are narrowed and transversely extended. The ribs are two-headed; the capitulum is received into a fossa of the posterior border of the intercentrum in advance of the vertebra which supports the diapophysis, to which the tuberculum is attached.

The curious mode of articulation of the ribs I have not observed in the species of the genera heretofore described, unless the forms of some of the intercentra of the *Clepsydrops limbatus* indicate it. If so, that species must be removed to *Embolophorus*.

Char. Specif. Centra with a circular section at all points, and contracted at the middle. No carinæ or grooves. The intercentra project beyond the edges of the centra, giving the column the appearance of supporting annular ridges. Their lateral angles extend upwards nearly to the base of the neural arch. The diapophyses are short and are directed upwards and forwards; their extremities are concave. The zygapophyses are large and their articular faces nearly horizontal. The size of this species is small, little exceeding that of the *Bolosaurus striatus*.

Measurements.	M.
Length of a centrum with an intercentrum attached....	.0056
Length of centrum....................................	.0040
Diameter of centrum { vertical.....................	.0035
Diameter of centrum { horizontal...................	.0035
Expanse of diapophyses...............................	.0080
" heads of rib............................	.0035
Elevation to summit of neural canal..................	.0045

Comparison with the vertebræ which I have found associated with the jaws and teeth of *Bolosaurus striatus* reveals the following differences: The neural arches of the latter are distinct; the intercentra are not present on the vertebræ observed (five in one series and five in another); and the centra are compressed with inferior rib. There are no capitular articular facets in the vertebræ of *Bolosaurus* described.

THEROPLEURA RETROVERSA. Gen. et spec. nov.

Char. Gen. Rhynchocephalian reptiles with free neural arch, and a capitular costal articulation on the centrum; the intercentrum probably, and the hyposphen certainly, wanting.

This genus is similar to *Lysorophus* in its free neural arch, but there is no capitular costal articulation on the known vertebræ of that genus. The small costal face of the diapophyses is distinct from what is seen in *Epicordylus* and *Empedocles*.

Char. Specif. Size medium, or rather larger than that of *Clepsydrops natalis.* A number of small vertebræ may belong to a young individual, but I regard as type a dorsal vertebra of an adult, where the suture of the neural arch is visible but adherent. The species is characterized by the wide posterior expansion of the border of the articular face of the centrum, forming the capitular facet for the rib. It approaches near to the diapophysis, and descends to the basal fourth of the centrum. There is an angular ridge passing backwards from the inferior border of the diapophysis to the border of the articular face. Below this angle and behind the capitular costal face the centrum is deeply concave, the concavities of the opposite sides being separated below on the median line by a narrow obtuse keel. The centrum is as deep and long as wide.

Measurements.	M.
Diameter of centrum { antero-posterior..............	.025
Diameter of centrum { vertical......................	.025
Diameter of centrum { transverse....................	.025

The small specimens agree with the large one in the strong, longitudinal angle connecting the diapophysis with the posterior border of the centrum, and in the wide capitular articular surface.

THEROPLEURA UNIFORMIS. Sp. nov.

This species is represented by the vertebræ of two individvals, and perhaps of two others of smaller size. The dorsal centra are characterized by

* Proceedings Amer. Philos. Soc., 1877, p. 187.

the absence of lateral and inferior edges, and the narrow reflected portion of the anterior border for the capitular facet. The diapophyses are short, and the tubercular surfaces not much extended. The zygapophysial surfaces are but moderately oblique. The sides of the centrum are gently and uniformly concave, and the inferior middle line is obtuse and not prominent.

The centra of the smaller specimens alluded to, are a little depressed, and may pertain to another part of the column.

Measurements.

		M.
Diameters of centrum	antero-posterior	.021
	transverse	.022
	vertical	.021
Expanse of anterior zygapophyses		.019
Width of neural canal		.009

THEROPLEURA TRIANGULATA.

The centra of the vertebræ of three and probably four individuals represent this reptile. The superior part of these resembles that of the *T. uniformis* in lacking the angle posterior to the diapophysis seen in the *T. retroversa*, and in the small extent of the capitular rib-facet. The inferior part of the centrum differs in the presence of three longitudinal rib like angles, separated by two latero-inferior shallowly concave faces. The median rib is not very prominent, is obtuse, and concave in profile. The articular faces are relatively rather wider than in the vertebræ described as typical of the two species preceding; but in one vertebra (No. 2) the proportions are nearly the same.

In the second vertebra mentioned the neural arch is entirely preserved. The diapophysis is at its base, and of small size; the vertebra is from not behind the median dorsal region. The neural spine is compressed and elevated, and with narrow, truncate apex. The articular faces of the zygapophyses are nearly horizontal.

Measurements.

		M.
Diameters centrum No. 1	antero-posterior	.018
	transverse	.017
	vertical	.016
Diameters centrum No. 2	antero-posterior	.023
	transverse	.024
	vertical	.026
Expanse of anterior zygapophyses		.020
Elevation of neural spine above zygapophyses		.052
Diameter of do. at summit	fore and aft	.016
	transverse	.007

BATRACHIA.

ERYOPS MEGACEPHALUS Cope. Proceed. Amer. Philos. Soc., 1877, p. 188.

To the characters which I have ascribed to the genus *Eryops* as above cited, I now add the following. A series of a few large teeth much exceed-

ing the maxillaries in size within the latter, perhaps on the palatine bone. No row of smaller teeth within the maxillary series, or on the vomer, as in *Mastodonsaurus* and *Capitosauras*. The choanæ are large, and extend well forwards.

This species is the most abundant as well as the largest Batrachian of the formation. Some of the crania are .500 Ms. in length.

It may be added that the vertebræ which I described (l. c.) under the head of this species, and which were found with the cranium which represents it, may not really belong to it.

PARIOXYS FERRICOLUS. Gen. et sp. nov.

Char. Genericus. Suborder *Labyrinthodontia.* Head of medium proportions, with orbits near the middle of the length, and lateral external nares. Epiotic bones prominent, bounding a deep auditory notch. Mandibular angle projecting beyond the glenioid cavity. Maxillary and premaxillary teeth not large, conic, subequal; within them a series of rather numerous teeth, of near the same size, probably rising from the palatine bone. No lyra discoverable.

This genus resembles *Rhinosaurus* and *Eryops*, but belongs to the group with prolonged mandibular angle. Among these it differs from *Mastodonsaurus* and its immediate allies in the deep auditory notch and prominent epiotic bones. From *Labyrinthodon* and *Anthracosaurus*, the uniform sizes of its teeth distinguish it; while there is no indication of the facial fontanelle of *Dasyceps*, which is otherwise much like *Parioxys*.

Char. Specif. This salamander is represented by two crania of similar size, to one of which a few vertebræ are attached. I have not yet removed the matrix enclosing the latter, as it is a task requiring much time. The general form of the skull is a triangle with rounded sides and narrowed and obtuse apex. The parietal region is rather elevated and wide, and is bounded laterally by a low, angular ridge which extends anteriorly from the epiotic angle, diminishing in prominence to the orbit. The external border of the epiotic next the auditory notch is acute, and the posterior angle is decurved, as though it formed the rim of a large *membranum tympani.* Between the epiotic cornua the supraoccipital border is concave The middle of the parietal region is concave.

The orbits are large and have prominent rims, which separate a concave interorbital region, which is less than half as wide as the longest (anteroposterior) diameter of the orbit. The rim is most prominent at the front of the orbit, anterior to which the side of the muzzle is somewhat swollen. There is no canthus rostralis; in its stead there is a concavity behind the nares, with an intervening swelling just behind the latter. These are equally lateral and superior in their presentation. The middle of the muzzle is slightly concave, with a low median longitudinal ridge. If there be any sculpture of the surface of the cranial and mandibular bones, it must be slight; where the thin layer of fine grained matrix which invests it has been removed, it is smooth.

The crowns of the teeth are rather slender; one from the posterior part

of the premaxillary bone does not display any cutting edges nor facets. The grooves of inflection are strong, and extend well towards the apex, but they are not numerous.

Measurements.	M.
Length of skull from muzzle to epiotic angle	.100
" " " supraoccipital	.090
" " " front of orbits	.045
" " " nares (axial)	.012
Width of skull at extremities of quadrates	.083
" " between epiotic angles	.035
" " " orbits	.015
" " at front of orbits	.066
" " between nares	.015
Lóng diameter of orbit	.025

From the same locality and horizon as the last species.

CRICOTUS HETEROCLITUS Cope.

Proceed. Academy Philada., 1876, p. 405. American Naturalist, May, 1878 (published April 22d), p. 319.

Specimens of a number of individuals probably referable to the above species, exhibit many of its characters. These are very remarkable, and indicate another type of vertebral column heretofore unknown.

The intercentra are more largely developed than in any other genus, having the form and proportions of the centra in the caudal region, and being but little smaller in other portions of the column. In the prepelvic region, the true centra only bear neural arches, which are articulated, and bear short diapophyses at their base. On the caudal region they share the neural arches with the intercentra, while the latter bear the continuous chevron bones exclusively. The neural spines are well developed, and not prolonged, in both regions. The ribs are robust, and the abdomen is protected beneath by a series of long, narrow and flat scales, which form imbricated chevrons directed forwards at the middle line.

The phalanges are short and wide, with but slightly condyloid articulations. The distal one is very short, and terminates in a narrowed obtuse projection, somewhat like those of man, but shorter.

A cranium which accompanied the portions of the trunk above described, may belong to the same species. It is that of a Labyrinthodont in some degree allied to *Trematosaurus.* Its form is elongate and the orbits are behind the middle. The mandibles do not exhibit prominent angles, and the epiotic angles are not distinguished by a notch from the posterior border of the os-quadratum. The epiotic bones and two supraoccipitals form the posterior boundary of the table of the cranium ; anterior to which the usual parietals and pterotics extend to the frontals and post-frontals. Below the latter is the postorbital, which is bounded behind by the squamosal (supra-squamosal, Owen, Palæontology, p. 176). The quadrato-jugal is possibly distinct from the large malar. There is a "lyra" of two grooves,

which are widely separated on the anterior part of the muzzle, and which converge in front of the orbits, which they barely reach. Another groove occupies the inferior margin of the dentary bone. There is a deep auricular fossa beneath the epiotic and posterior part of the pterotic bones. There is but one series of teeth on each maxillary and dentary bone exposed by the present condition of the specimen. The teeth are subequal, gradually increasing in size anteriorly where their long diameters are transverse to the axis of the dentary bone. The surface of the cranial bones is not strongly sculptured. Posteriorly it is rather closely, and anteriorly it is sparsely, punctate. The sculpture of the lower jaw is similar, except that it is smoother posteriorly.

As this species has been already described, further detail is not now given. The present specimens show that the species was founded on a caudal intercentrum, and that the *C. discophorus** was founded on dorsal intercentra. They also show that my original reference of loose phalanges to this genus was correct.

ZATRACHYS SERRATUS. Gen. et sp. nov.

Char. Gen. The existence of this genus is demonstrated by various fragments, the most characteristic of which is a portion of a maxillary bone. This probably belonged to a species of the order *Stegocephali*, but whether to the Ganocephalons or Labyrinthodont division is uncertain, though the evidence is in favor of the former. The teeth are in a single series, and their bases are anchylosed to the bottom of a shallow groove. The external boundary of this groove is more prominent than the internal, so that the attachment of the teeth is shortly pleurodont. The teeth have conic crowns, and have basal grooves indicating the dentinal inflexions common to this group. The maxillary and other bones are characterized by their strong sculpture, in the former the ridges being developed into prominent tubercles in various places.

Char. Specif. The horizontal expansion of the maxillary bone is a character of this species, so that its plane forms an obtuse angle with that of the long axes of the teeth. It presents no palatal lamina. The teeth are separated by intervals of greater width than the diameter of the base. The border of the bone above the teeth is thickened, and the ridges are developed into numerous tubercles. These project externally so as to form a prominent serrate margin entirely overhanging the external alveolar border. The ridges diverge inwards in a radiating manner. The surface is otherwise irregular from the presence of a deep fossa on the outer side within the inner alveolar border.

Measurements.	M.
Length of fragment	.018
Width " "	.018
" " " alveolar groove	.002
Length of prominences beyond alveolar border	.003
Diameter of a tooth basis	.001
Three teeth in	.005

* Proceed. Amer. Philos. Soc., 1878, p. 186.

TRIMERORHACHIS INSIGNIS. Gen. et sp. nov. Ganocephalorum.

See American Naturalist, May (April 22), 1878, p. 328.

This genus is referred to the *Ganocephala* of Owen, as a Stegocephal Batrachian with vertebral centra represented by separate cortical ossifications, and with the chorda dorsalis persistent in the basioccipital region. The basioccipital bone, although ossified, supports no condyles properly so called, but a cup-like articulation for the first vertebra, like that of fishes, but which is perforate for the chorda dorsalis. It possesses the other characters of the suborder in the presence of zygapophyses and of the quadratojugal arch.

Char. Gen. The centrum is represented by three cortical ossifications of the chorda-sheath, a median inferior, and two lateral. The lateral pieces are quite distinct from each other, and are in contact with the neurapophyses above, and the posterior border of the median segment in front. The neural arch joins chiefly the lateral elements, but is in slight contact with the lateral summits of the inferior element. The halves of the neural arch are coössified, and support well developed zygapophyses, but no neural spine. A lateral expansion of the base of the neurapophyses represents the diapophysis, but it is horizontal and thin.

The cranial bones are sculptured with pits and reticulate ridges. The parasphenoid bone is flat. The external nostrils are large and superior, and not anterior. The angle of the mandible is little produced, and the glenoid cavity is transverse and wider at the inner than the external extremity. The inner wall of the mandible descends from the glenoid fossa, including with the horizontal outer wall, a deep internal pterygoid fossa. No coronoid bone or process. Symphysis short.

The teeth exhibit the inflected dentine of this and allied groups. So far as preserved, they are simply conic, but there are none with the apices complete. There are two series on each side of the upper jaw, both of which consist of larger teeth at their anterior portions. The anterior teeth of the inner row beneath the external nares, are much the largest. A thin bilateral bone from some part of the roof of the mouth supports some large teeth, and a row of small ones diverging from them on each side. The mandibular teeth are in one principal series, and become a little larger anteriorly. Near the symphysis there are on each side, within the external row, one or two large teeth. The ribs are short and little curved, and they have flat expanded heads. They are attached to the diapophysial expansion of the neural arch. Such limb bones as are preserved are without condyles, and are of relatively small size.

Trimerorhachis differs from *Archegosaurus* in the ossification of the basicranial elements; in the absence of attached neural spines, and in the regular and definite tripartite ossification of the chorda-sheath. The form of the cranium of *Trimerorhachis* is unknown.

Char. Specif. There are two large tusks at the anterior extremity of the inner superior row of teeth, and two similar ones on the plate-like element above described. The inferior border of the mandible rises gradually posteriorly to below the posterior border of the glenoid cavity, behind

which is a short vertical and compressed angular process, which is rounded in profile. There is a patch of small teeth inside of the posterior extremity of the mandibular series. The mandible closes inside of the posterior part of the quadrato-jugal arch. There is a groove near the inner margin of the inferior face of the mandible ; external to this the surface is marked with elongate shallow pits. The sculpture of the external side of the ramus is less pronounced, and the pits are smallest near the angle. The pits of the top of the cranium are coarse and well defined. The fragment of maxillary bone is broken off four teeth behind the tusks, and the neural opening has contracted but little at that point. The sculpture of the anterior portion of the maxillary is coarsely reticulate.

The diapophyses of the centrum are oblique rhomboids in form, the anterior upper side receiving the neural arch. The external surface is concave and smooth. The median element, which I call the intercentrum,* is a crescent with subacute horns, which terminate below the anterior part of the posterior zygapophyses. The inferior surface is slightly angulate, with two low latero-inferior ridges, and sometimes a low median one. The surface between them is delicately reticulately sculptured. The neural arch is oblique and highest behind. The combined neurapophyses rise rather abruptly behind the anterior zygapophyses with an obtuse and convex margin. They then descend in an arc to the extremities of the posterior zygapophyses, diverging downwards and separated by an open groove which was doubtless the basis of attachment of the cartilage which represented the neural spine. External surface of the neurapophyses smooth. The zygapophyses have little lateral expansion, but are well defined and prominent antero-posteriorly. The processes which I have alluded to above as diapophyses, may not be such, as they are simply transverse expansions of the anterior inferior portion of the neurapophyses, whose posterior border articulates with the lateral diapophyses of the centrum.

The basioccipital condyloid fossa† is transversely hexagonal in outline, the superior border being deeply notched by the superior portion of the *fossa chordæ dorsalis*. The articular surface itself is funnel-shaped. The parasphenoid bone advances far posteriorly under the basioccipital. It expands into an acute angle on each side below the proötic, and then contracts, so that its sphenoid region is narrower than its occipital extremity. Its surface is slightly concave.

Measurements.	M.
Depth of maxillary bone at middle of nares	.021
Width of palatal surface " "	.014
Six maxillary teeth " "	014
Diameter of an anterior maxillary tooth	.002
" " tusk of inner row	.004
Length of ramus mandibuli to anterior border of internal pterygoid fossa	.058
Depth of do. at do	.023

* American Naturalist, May, 1878, p.323.

† This term is used as preferable in this case to that of occipital condyle.

Measurements.	M.
Length of ramus mandibuli to posterior border of internal pterygoid fossa	.015
Depth of ramus mandibuli at do	.016
" " " .110 from angle	.016
Six posterior mandibular teeth in	.011
Transverse extent of glenoid cavity	.012
" diameter of condyloid fossa of occiput	.019
Vertical diameter of do	.013
Greatest width of parasphenoid	.034
Thickness of do. at sphenoid portion	.0035
Three vertebræ (measured below) in	.042
Chord of intercentrum	.018
Length of intercentrum below	.010
Thickness " "	.002
Total length of neural arch	.017
Elevation of do. above posterior zygapophyses	.008
Expanse of anterior zygapophyses	.007
Long diameter of lateral diapophysis	.012
Short " " "	.005
Length of a rib	.021
Width of head of do	.008

This species was abundant during the Permian period in Texas, judging from the number of individuals included in my collection.

RHACHITOMUS VALENS. Gen. et sp. nov. Ganocephalorum.

Char. Gen. These are derived exclusively from vertebræ, which appear to belong to only one species. Four is the largest number which has been found consecutively in any one individual, isolated portions of the vertebræ being more abundant. From these, characters of an interesting genus allied to *Trimerorhachis* may be derived.

Each vertebra consists of two segments,—an intercentrum and a neural arch. The true centrum is wanting in the specimens at my disposal, and the intercentrum supports portions of two adjacent neural arches. With these it shares the intervertebral articular face usually borne by the centrum. Each articular face is thus divided into three portions, one third belonging to each neurapophysis, and one third to the intercentrum. Between these the course of the chorda dorsalis is unobstructed. Neural spine present, coössified. Diapophysis large, with a subvertical tubercular costal face. Zygapophyses well developed.

The absence of centrum and presence of neural spine and articular faces on the neurapophyses, with the well-developed diapophyses, distinguish this genus from *Trimerorhachis.* The large intercentra and articular faces of the neural arch distinguish it from *Archegosaurus.*

Char. Specif. The *Rhachitomus valens* is a much larger species than the *Trimerorhachis insignis,* equaling or exceeding the *Empedocles alatus.* The intercentra are very robust; the posterior face is nearly straight, while the inferior border of the anterior face curves backward to meet the

former at an angle. The inferior face is convex transversely, and slightly concave antero-posteriorly. The tubercular rib facets are oval, and are narrowed downwards and forwards. The side of the neurapophysis describes a curve which rises a little to the superior part of the extremity of the diapophysis. The zygapophysial surfaces are as wide as long, and a little oblique. The neural spine is not very elevated, and is very robust; its section is a longitudinal oval. Its summit is truncated and thickened laterally.

Measurements.	M.
Diameter of intercentrum { transverse	.035
Diameter of intercentrum { antero-posterior	.023
Expanse of diapophyses	.073
Length of tubercular surface of do	.022
Elevation of neural arch	.071
" " spine	.040
Antero-posterior diameter of summit of do	.044

Pisces.

Ctenodus periprion. Sp. nov.

This large species is indicated by a fine palatal tooth of the left side. Its outline approaches that of a right-angled triangle, but the hypothenuse is deeply incised by the interradial notches. The plate is rather thin, and is moderately concave on the inferior face. The ridges number seven, all of which are directed outwards and forwards. They are separated by strong grooves, and have a perfectly smooth and uniform crest, and become more elevated at the distal extremities. The latter are steeply decurved and serrate, both faces being invested with a polished enamel-like layer. This substance is only visible in an edge view, and covers one-half the depth of the margin, being excavated by the extremities of the radiating grooves. The superior face is flat.

The absence of serration from the radiating ridges of this species is a striking feature, allying it to the genus *Ptyonodus*,* where the teeth are wanting.

Measurements.	M.
Length of dental plate	.037
Width " "	.018
Thickness at inner border	.005
" " external border of penultimate crest	.007

From the same locality as the species above described.

Ctenodus porrectus. Sp. nov.

Two teeth of the left palate indicate this species. The tooth is characterized by the small number of its crests (six), of which only one, the very small first, is directed backwards, and the last four are directed forwards. The crests are separated by deep grooves, which terminate in deep emarginations. The anterior crest is produced much beyond the extremity of the penultimate, and the latter as much be-

*Proceed. Amer. Philos. Soc., 1877, p. 192.

yond the fourth. The extremities of the crests extend obliquely to their bases, and support four or five dentiform processes. The dense shining layer extends inwards as far as the bases of the serrate portions. The inner face of the anterior crest is oblique, and the posterior inner border curves outwards to behind the first crest, leaving a shelf-like continuation of the palatal surface of the tooth.

Measurements.	M.
Length of tooth	.038
Width at third crest	.015
Depth opposite third crest	.004

This species must be compared with *C. fossatus* Cope, and *C. serratus* Newb. The latter is a wide tooth with less oblique, and fully serrate crests. The former is a narrow species, but the anterior crests are not nearly so extended; it is deeper, and the inner side is vertical, and without the posterior palatal lamina seen in the two species named.

Ctenodus dialophus. Sp. nov.

Represented by a single left tooth in excellent preservation. Its characters are very marked. It is of narrow form, and has more numerous crests than any other known American species. They number ten, and there are two or three other rudimental ones at the posterior extremity. They are all more transverse than usual, five being directed forwards, and five slightly backwards. The crests are acute, but the grooves and emarginations are not very deep. The crests are entire, except at the obliquely truncate distal extremities, where there are from two to four dentations. The shining layer does not extend within these. The inner border of the tooth is vertical, excepting posteriorly, where the inner border of the crest-bearing portion turns outwards, leaving a narrow ledge of the palatal face. The latter is concave in cross section.

Measurements.	M.
Length (.004 at one end inferential)	.033
Width at fifth crest	.010
Depth opposite fifth crest	.004

It is not necessary to compare this species with any other.

Observations on the Pelycosauria.

In addition to the type of humerus described under the head of the genus *Clepsydrops*, several other remarkable forms occur in the collection, which are probably referrable to the various genera of *Pelycosauria*. I give the following tabular analysis of them :

A. No condyle ; a supracondylar foramen. No special proximal articular surfaces.

No. 1. (*Clepsydrops*) .... Specimens ,5.

AA. Condyles and supracondylar foramen.

a. The shaft uninterrupted.

No. 2. Condyles longer ; smaller.................................Sp. 6.

No. 3. Condyles wider ; larger ....Sp. 4.

aa. The shaft interrupted by a prominent diagonal ridge.

No. 4. Epicondyles and ridges enormous..........................Sp. 1.

AAA. No supracondylar fossa ; condyles as in *AA.*

No. 5. Form more slender...Sp. 3.

No. 6. Form more robust...Sp. 1.

The above humeri represent three, and perhaps four genera, which have been probably already named from crania or vertebræ in the preceding pages. No. 1 has been already identified as belonging to the *Clepsydrops natalis.* Nos. 2 and 3 are generally similar to the type referred by Meyer to the *Eurosaurus* of Fischer, which had been previously described as Mammalian by Kutorga ; but the epicondyles are more largely developed. Humerus of form No. 4 is very remarkable, resembling in some degree that of a mole, being exceedingly robust, and having the muscular insertions enormously developed. It doubtless belonged to a fossorial animal, possessing great power in the anterior limbs. If we search for vertebræ presenting features corresponding to such a mode of life, we sieze at once on those of the genus *Empedocles.* Here the elevated roof-like character of the zygapophyses and the connecting platform suggest protection against superincumbent weight, while additional strength is obtained by the hyposphen articulation below them. The short wide neural spine is highly appropriate also to subterranean habits. It is also probable that the animals possessing the humeri, from No. 2 to No. 6 inclusive, were all more or less fossorial. Humeri Nos. 5 and 6 have the characters of Nos. 2 and 3, but the supracondylar bridge is wanting, and the internal epicondyle not quite so much expanded.

The division *Pelycosauria* is established primarily on the genera *Clepsydrops* and *Dimetrodon,* but their cranial structure renders it highly probable that *Ectocynodon, Pariotichus* and *Bolosaurus* belong to it. It is also probable that the genera *Empedocles, Embolophorus* and others determined from vertebræ belong to it, as the latter are frequently accompanied by pelvic bones of the type of that of *Dimetrodon.* All the genera known from teeth and crania, are of carnivorous habit, excepting *Bolosaurus* and *Diadectes ;* they may be referred to a single family on this account, which I call the *Clepsydropidæ. Bolosaurus* will form the type of another family characterized by the transverse position of the crowns of the teeth, under the name of *Bolosauridæ.* Prof. Owen has named a group of Triassic and Permian reptiles the *Theriodonta,* characterized by the mammal-like differentiation of the incisor and canine teeth. The animals thus referred by Prof. Owen probably enter my suborder of *Pelycosauria,* although the structure of their pelvis remains to be ascertained. If so, they correspond with my *Clepsydropidæ,* since Prof. Owen does not include herbivorous forms in his division. As it is plain that the herbivorous and carnivorous types belong to the same order, and probably suborder, it becomes necessary to subordinate the term *Theriodonta* to that of *Pelycosauria.* To another division of reptiles from the South African Trias typified by the

genus *Pareiasaurus* Ow., he gives a special name, expressive of the deeply impressed surfaces of the centra occupied by the remains of the chorda dorsalis. As this, or the perforate condition, is characteristic of all of the *Pelycosauria,* it is probable that it is present in Prof. Owen's *Therodontia* also. It is also evident that since the dental characters of *Pareiasaurus* do not serve to distinguish it as an order from the genera with distinct canine teeth, this group also must be looked upon as a subdivision, perhaps of family value, of the *Pelycosauria* or other parts of the Rhynchocephalous order.

The Texan genera of this group, so far as yet known, are about equally related to the Ural and South African types. The age of the former deposit is the Permian, which includes, according to Murchison, the Todtliegende and Zechstein of Thuringia. The age of the South African beds is uncertain, but is suspected by some authors to be Triassic, and by Owen to be Palæozoic. In discussing the age of the *Clepsydrops* shales of Illinois, which had been referred to the coal measures by all previous investigators, I left the question open as to whether they should be referred to the Permian or Triassic formations.* The evidence now adduced is sufficient to assign the formation, as represented in Illinois and Texas, to the Permian. Besides the saurian genera above mentioned, the existence of the ichthyic genera *Janassa, Ctenodus* and *Diplodus,* in both localities, renders this course necessary.

Theses.

1. The horizon of the *Clepsydrops* shales of Illinois and corresponding beds in Texas is Permian.

2. That this period witnessed an abundant life of land and ichthyic vertebrata, the former consisting of Rhynchocephalian reptiles and Stegocephalous *Batrachia.*

3. That in the land vertebrata of this period, the amphiplatyan, procœlous, and opisthocœlous types of vertebral articulation were unknown, and that the vertebral centra are either deeply amphicœlous or notochordal.

4. That in the case of both the *Rhynchocephalia* and *Stegocephali,* a specialized dentition, and in the former order, a specialized limb structure, were superadded to this imperfect vertebral structure.

5. That in the primitive land *Vertebrata* of the Permian, the place of the vertebral centrum was occupied by two elements, the centrum and intercentrum.

6. That the intercentrum, from a position of primary importance, as in *Rhachitomus* and *Trimerorhachis,* became reduced, and finally mostly obliterated, but that it remains at the present day in the anterior dorsal region of some *Lacertilia,* and as the chevron bones of most reptiles and some mammals.

* Proceedings Academy Philadelphia, 1875, p. 405.

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CONTRIBUTION

TO THE

VERTEBRATE FAUNA OF THE MIOCENE

OF OREGON.

By E. D. COPE.

FOR SALE BY

A. E. FOOTE, 1223 Belmont Avenue, Philad'a.

On some of the Characters of the Miocene Fauna of Oregon.

(*Read before the American Philosophical Society, November* 15, 1878.)

BY E. D. COPE.

We have been for some time in possession of information as to the ungulate forms which inhabited Oregon during the Miocene period. Through the labors of Profs. Leidy, Marsh and Bettany, we have learned of the existence there of *Oreodontidæ* in considerable variety; of *Anchitheriidæ*; of peccary-like species; of *Elotherium*, and of *Rhinocerus*. But of the unguiculate types, of *Rodentia*, and of the inferior orders of Mammalia, almost nothing is yet known. Having recently received a number of specimens from the deposits in question, I am in a position to offer a number of new identifications. The following species already known from the Miocene of Colorado, I find contained in the collection, viz.: *Palæolagus haydeni; Canis gregarius; Canis lippincottianus; Hyperragulus calcaratus; Leptomeryx evansi.*

RODENTIA.

STENEOFIBER GRADATUS, sp. nov.

This species is represented in my collection by a cranium which is nearly perfect, the principal deficiency being the absence of the mandibular rami. It is of smaller size than the *S. nebrascensis* and *S. pansus*, and differs from both these species in the relative sizes of the superior molar teeth. The first of these is the largest, and the others diminish regularly in size to the last, whose grinding face does not present more than one-third the extent of that of the first. The triturating surfaces of the second and third have their long axes transverse. In all the crowns, besides the internal and external enamel inflections, there is but one fossette, which is anterior to the external inflection. The latter has become isolated from the superficial enamel on the last three molars, by attrition. The superior incisors are flat anteriorly with the external angle rounded, and its dentine presents the transverse undulations seen in *S. pansus*.

Measurements.		M.
Length of skull from incisive alveolus		.0500
Width between summits of first molars		.0060
" " fourth "		.0095
Length of molar series		.0115
Diameter of the first molar	antero-posterior	.0040
	transverse	.0045
Diameter of third molar	antero-posterior	.0028
	transverse	.0032
Diameter of fourth molar	antero-posterior	.0020
	transverse	.0024

From the above measurements it is apparent that the molar series in this species is equal in length to the anterior three molars of the *S. nebrascensis*

and *S. pansus*. The posterior fossettes of the crowns seen in those species are wanting in the *S. gradatus*.

ENTOPTYCHUS CAVIFRONS, gen. et sp. nov.

Char. gen. Probably of the family *Saccomyidæ*.* The cranium is elongate, and presents inflated periotic bones, and slender zygoma. The foramen infraorbitale is small and anterior in position, entering the maxillary bone near its suture with the premaxillary.

Generic characters. Molars $\frac{4}{4}$–$\frac{4}{4}$, rootless, and identical in structure. The crowns are prismatic, and in the young stage present a deep inflection of enamel from one side, the external in the superior teeth, the internal in the inferior. After a little attrition, the connection with the external enamel layer disappears, and there remains a median transverse fossette, entirely enclosed by enamel. The tooth then consists of two dentinal columns in one cylinder of enamel, separated by a transverse enamel-bordered tube. Incisors not sulcate.

The teeth of this genus differ from those of *Perognathus* in being without distinct roots, and in having the enamel loop cut off and enclosed. In *Dipodomys*, the molars are undivided simple prisms.

Specif. Char. This species is represented by some entire crania, and numerous separated jaws. The postorbital part of the skull is subquadrate in outline, and depressed in form. The interorbital region is narrowed, but the superciliary margins do not meet nor converge to form a sagittal crest. They are thickened, forming two subparallel ridges which are separated by a shallow concavity of the frontal bone. The nasal bones are very narrow, and their posterior apices just attain the line of the supero-anterior angle of the orbit. The base of the malar bone is much elevated and very oblique. The molar teeth are directed obliquely backwards, the alveolus of the first issuing below the anterior part of the orbit. The first superior molar is the largest, and the proportions of the others diminish regularly posteriorly. The first inferior molar is a little smaller than the second and third, and is about equal to the fourth. Its anterior column is contracted, while the last molar is like the second and third. The face of the inferior incisor is flat, and its enamel is smooth. The external face of the jaw is bounded below by a strong angle, as far anteriorly as below the first molar.

Measurements.	M.
Length of skull to incisive alveoli	.041
Width of skull at mastoids	.020
" " between orbits	.005
" " at middle of muzzle	.010
Elevation of skull from second molar	.011
Length of molar series	.007
" first molar	.002
Width of " "	.002
Length of crown of last molar	.0015

*See Coues' Report U. S. Geol. Surv. Terrs. XI, p. 491.

Measurements.	M.
Width of crown of last molar	.0015
Length from M. 1 to infraorbital foramen	.007
Depth of mandibular ramus at M. 2	.006
Width of face of inferior incisor	.0016

ENTOPTYCHUS PLANIFRONS, sp. nov.

A larger species than the *E. cavifrons,* represented in my collection by parts of crania, and rami. The former show that besides the superior size, this species differs from the *E. cavifrons* in the absence of the superciliary ridges, and hence perfect flatness of the interorbital region. The latter is also wider, measuring five-sixths the width of the muzzle at its middle, while in the *E. cavifrons* it is only half as wide. The subjoined measurements give the characters in detail.

Measurements.	M.
Width of interorbital space	.007
" muzzle at middle	.0086
Elevation of skull from second molar	.0130
Length of inferior molar series	.0072
Depth of ramus at M. 2	.0072
Width of inferior face at M. 2	.0043
" " incisor	.0018
Distance between infraorbital foramen and M. 1	.0050

ENTOPTYCHUS CRASSIRAMIS, sp. nov.

This, the largest species of the genus, appears to have been less abundant than the two already described. I refer to it portions of two crania and three mandibular rami, found separately. The superior size of the parts is obvious, the posterior three superior molars having the same longitudinal extent as the entire series of the *E. cavifrons.* The gradation in the size of these teeth, is as in that species, the grinding surfaces diminishing rapidly in extent posteriorly. The superciliary ridges are not well preserved, but were probably thickened as in *E. cavifrons,* and the interorbital space was relatively as narrow, and not so wide as in *E.planifrons.* The measurements below exhibit the characters more exactly.

Measurements.		M.
Width of skull between orbits		.007
Elevation of skull from second molar		.015
Length of series of superior molars		.0115
Diameter of second molar	antero-posterior	.003
	transverse	.004
Diameter of fourth molar	antero-posterior	.002
	transverse	.002

In the mandibular rami the inferior masseteric ridge extends to below the anterior border of the first molar, and is very prominent and acute. It results that both the exterior and inferior aspects of the ramus are con-

cave to the anterior extremity of the crest, which slopes upwards. The incisive alveolus, though not prominent as in the *Hystricomorpha,* is on the inner side of the base of the ramus in front, and the enamel-face of the incisor tooth is directed more inwards than downwards. Above the alveolar prominence, the inner face of the ramus is gently concave. The anterior origin of the coronoid process is opposite the posterior border of the second molar.

Measurements.	M.
Length of inferior molar series	.0105
Width of anterior face of inferior incisor	.0028
Depth of ramus at M. 2	.0085
Width of ramus below at M. 2	.0070

PLEUROLICUS SULCIFRONS, gen. et sp. nov.

Char. gen. Fam. Saccomydiæ. Superior molars rooted and short-crowned. The crowns with a lateral fissure bordered with an inflection of the enamel sheath, extending to their bases. In the superior molars this inflection is on the external side, and does not divide the crown. Superior incisors not grooved.

This genus is curiously near to the existing *Heteromys* and *Perognathus,* the two genera of *Saccomyidæ* with rooted molars. The former differs in having the molars divided into two columns, each of which is sheathed in enamel, while *Perognathus* only differs so far as I am aware, in having the superior incisors grooved.

Specif. Char. This species resembles those of the allied genus *Entoptychus* in many respects. The superciliary borders are thickened upwards, forming two ridges, which enclose a groove between them which is more pronounced than in the *Entoptychus cavifrons.* The muzzle is plane above and considerably wider than the interorbital space. The base of the malar is thin and oblique, and the *foramen infraorbitale exterius* is well in advance of the molar teeth and at the anterior part of the maxillary bone. A groove passes backwards from its inferior border, terminating in a small foramen which marks a point nearly half way to the first molar. Within this, another shallow groove bounds the more prominent median line. The palatal surface exhibits two shallow lateral grooves, which commence opposite the posterior border of the first molar.

The grinding surfaces of the molars are transverse ovals, only interrupted by the exterior fissure. The first molar is slightly different in form, being larger, and its section, when not much worn, being nearly round. Its anterior portion extends towards the alveolus, giving an antero-posterior oval, on prolonged wear. Each tooth has three roots, one interior and two exterior; in the first they may be described as two posterior and one anterior. The last molar is the smallest, the series exhibiting a regular gradation in size.

Measurements.	M.
Interorbital width	.0050
Width of muzzle at middle	.0080

Measurements.	M.
Depth of cranium at M. 2	.0138
Length of molar series along base	.0080
Diameter of second molar { antero-posterior	.0016
Diameter of second molar { transverse	.0020
Width of face of superior incisor	.0020

MENISCOMYS HIPPODUS, gen. et sp. nov.

Gen. Char. The characters of this genus are derived from the dentition of both jaws, and from portions of the cranium which are preserved. The molars are rooted, and number $\frac{4}{4}$. Those of the superior series are without enamel inflections, and the triturating surface exhibits two external and one internal crescentic sections of the investing enamel. On the second superior molar there are three external crescents in the typical species ; and the first molar is simply conic. Between the inner and external crescents, there are the curved edges of enamel plates directed obliquely and transversely. The grinding surfaces of the inferior molars display in the unworn condition, two L-shaped transverse crests, connected longitudinally on the median line ; on wearing, the lateral emarginations of the enamel become shallower, disappearing from the inner side, but remaining on the outer. Incisor teeth not grooved. *Foramen infraorbitale anterius*, if present, elevated in position and near orbit.

The characters of the dentition of this genus resemble those of the genus *Pteromys*, which is now confined to Asia and the Malaysian Archipelago. The superior molars differ from those of *Pteromys* in wanting all reëntrant enamel inflection. Specimens in my collection indicate two species of *Meniscomys*.

Specif. Char. Superior molars with a vertical ridge from the points of junction of the crescents on the external side ; there are thus two on the second molar, and one each on the third and fourth. Within each of the external crescents is another crescentic edge of a pair of vertical enamel plates, and the inner marginal crescent sends off a short transverse branch towards them. With attrition, all these crests unite by their extremities, enclosing four distinct lakes, which, after still further wear, disappear. Attrition produces a similar result in the inferior molars, viz.: two pairs of crescents enclosing four lakes, which ultimately wear out. The inferior incisor has a shallow concavity on its anterior face.

The maxillary bone, anterior to the molar teeth, is shorter than the premaxillary. The incisive foramina are entirely in the latter. The sides and superior aspect of the muzzle are regularly convex in transverse section. The inferior incisive alveolus is enclosed entirely in the plane of the ramus, and extends posteriorly to below the last molar tooth. The masseteric ridge is very oblique, and rises to a median point below the second molar. The coronoid process rises from the front of the last molar.

Measurements.	M.
Length of superior molar series	.008

Measurements.		M.
Diameter of second superior molar	antero-posterior...	.004
	transverse........	.0035
" third " "	antero-posterior...	.0020
	transverse........	.0025
Width of superior incisor............................		.0020
Length from base of first superior molar to base of incisor..		.0065
Width between bases of first molars..................		.0020
Length of first inferior molar.........................		.0033
Depth of ramus at second molar......................		.0050
Width " below "		.0035

MENISCOMYS MULTIPLICATUS, sp. nov.

This species is considerably larger than the *M. hippodus*, and differs in the greater complication of the enamel plates of the inferior molars. The four crescentic areas are discernible on the worn surfaces of the crown, of which the posterior inner is reduced in size on the middle two molars. The two enclosed lakes have very plicate borders which form many small loops, and sometimes they are fused into a single irregular area. The last molar is extended a little posteriorly, and all present an entrant angle between the inner columns. The coronoid process originates opposite the third molar, and the masseteric ridge ceases below the middle of the jaw below the second molar.

Measurements.		M.
Probable length of inferior molar series..............		.0120
Length of posterior three molars......................		.0095
Diameter of second molar	antero-posterior...........	.0030
	transverse................	.0025
Length of fourth molar................................		.0040
Depth of ramus below second molar..................		.0070
Width " " "		.0050

CARNIVORA.

TEMNOCYON ALTIGENIS, gen. et sp. nov.

Gen. Char. This genus is only known from a mandibular ramus which supports all the teeth excepting the incisors and probably the last molar. There are four premolars and probably three true molars, all having the general character of those of *Canis*. The only character by which I distinguished the new genus *Temnocyon* is seen in the form of the heel of the sectorial tooth. Instead of presenting a concave surface bounded by ridges or tubercles, it presents a more or less median cutting edge as in the posterior premolars of *Oxyæna*. In the typical species, there is but one row of cusps on the first tubercular molar, but they are not elevated, and stand on one side of the crown. In comparing this genus with types other than *Canidæ*, one can recognize in its characteristic peculiarity of the sectorial

tooth, one well-known in the typical genera of *Viverridæ* and *Mustelidæ*. *Temnocyon* is, however, truly canine in other details, and appears to approach the genus *Palæocyon* of Lund. According to this author, the posterior inner tubercle of the anterior part of the crown of the sectorial tooth is wanting in that genus, so that it is distinct from the North American form.

Specif. Char. The mandibular ramus is rather deep and compressed, much more so than in the *Canis latrans*, with which it agrees in the length of the dental series. As compared with the existing species of *Canis* and *Vulpes* of North America, the sectorial tooth is relatively smaller and the premolars larger. In this respect it agrees with most other dogs of the Lower Miocene, and differs from those of the Upper Miocene (Loup Fork).* The posterior tubercle is wanting from the premolars, excepting the last, where it is large and obtuse, differing in this respect also from most recent dogs, and from the cotemporary *Canis gregarius*. In the sectorial tooth the principal cusp is much elevated above the anterior, while the inner median is small, with its apex in line with the anterior. The cutting edge of the heel is not acute, and is a little external to the median line; there is a weak cingulum-like angle at its inner base. The first tubercular tooth is large, nearly equaling in antero-posterior diameter the base of the third premolar. It is parallelogrammic in transverse section, and supports two principal cusps and an anterior ledge. The cusps are pronounced and stand exterior to the middle line; their inner side slopes to the base of the crown where there is no cingulum. The ledge is higher on the inner than the external side. There are no basal cingula on either side of the bases of any of the teeth. The second tubercular molar is lost.

The alveolar margin of the jaw rises behind the sectorial tooth, and the inferior margin begins to ascend below the middle of the same tooth more decidedly than in *C. lupus, latrans* or *cuspigerus*. The two large mental foramina, are situated, the one below the second, the other below the third premolars.

Measurements.

	M.
Length of anterior six molars	.073
" " four "	.045
" base of second premolar	.011
Elevation of crown " "	.011
Length of base of fourth "	.015
Elevation of crown " "	.014
Length of base of sectorial tooth	.0185
Elevation of principal cusp of sectorial tooth	.0160
" anterior " " "	.009
Length of heel of sectorial	.007
Elevation " "	.0085
Length of crown of first tubercular	.0115

* See Proceedings Academy Philadelphia, 1875, p. 22, where I have discussed the origin and history of the sectorial tooth.

Measurements.	M.
Width of crown of first tubercular	.0065
Depth of ramus at P. M. 2	.024
" " at sectorial.	.028
Thickness " "	.010

CANIS CUSPIGERUS, sp. nov.

This peculiar species is indicated by the greater part of the cranium with dentition, to which are united both rami of the lower jaw with nearly all of the teeth in place. These indicate a dog of small size, about equaling the *Canis gregarius* Cope, but one presenting marked characters.

The third premolar tooth in both jaws differs from the corresponding one in the *C. gregarius* and in most recent species, in lacking the lobe of the posterior cutting edge, agreeing in this (as regards the inferior series) with the *Temnocyon altigenis.* It is present in the fourth inferior premolar, which has besides, a low heel. The inferior sectorial tooth is characterized by its great robustness ; the internal median tubercle is much elevated, while the principal cusp is short. The heel is wide and basin-shaped, with the inner border as much elevated as the outer. The first tubercular molar is characterized by its width as compared with its length being nearly as wide transversely as fore and aft. It has two anterior cusps followed by a basin with elevated borders simulating two posterior cusps. There are an anterior and a exterior cingulum. The second tubercular is a miniature of the first, differing in the more robust external posterior cusp, and the absence of external basal cingulum. There are no complete cingula on the external bases of the other inferior teeth. The second superior tubercular is well developed, having two external tubercles. The anterior inner cusp of the superior sectorial is distinct and acute, and there is a cingulum along the inner base of the crown. The exserted portion of the canines is long, slender, and with an oval section narrowed behind. The enamel of all the molars is more or less rugose, a character which is only found among our extinct dogs in the *C. geismarianus.*

The mandibular rami are shallow, and their inferior margin is not stout. A gentle elevation of the latter commences below the first tubercular tooth and the alveolar border rises but little behind. The masseteric fossa is deep and well defined.

Measurements.	M.
Length of inferior molar series	.041
" bases of four premolars	.023
" base of second "	.005
Elevation crown " "	.005
Length of base of fourth "	.0072
Elevation of crown " "	.0055
Length of base of sectorial	.010
Elevation of principal cusp	.006
Width of heel of sectorial	.006

Measurements.		M.
Diameter of first tubercular	antero-posterior	.006
	transverse	.005
Antero-posterior diameter second tubercular		.0037
Length of base of superior sectorial		.009
" bases of two tuberculars		.012
" base of first tubercular		.0064

CANIS GEISMARIANUS, sp. nov.

This species of dog may be placed with reference to the size of its inferior sectorial tooth between the *C. lippincottianus* and *C. hartshornianus.* In the robust proportions of this tooth it more nearly resembles the *C. cuspigerus.* The mandibular ramus is robust and shallow, and quite distinct from the deep jaw of *C. hartshornianus.* The sectorial has perhaps twice the bulk of those of the *C. lippincottianus* and *C. cuspigerus.* From that of the latter it differs further in the small inner tubercle and contracted heel.

The sectorial part of the tooth is relatively small, not exceeding the heel in length, and its cusps are low. The heel is notable for the elevation of the tubercle of the inner side—which exceeds that of the outer; the latter also, is contracted, standing within the external base, which is represented by a short cingulum. A weak cingulum below the sectorial blades. Surface of the enamel rugose where not exposed to friction.

Measurements.		M.
Diameters of sectorial	vertical, anterior cusps	.006
	" heel	.0038
	antero-posterior	.0115
	transverse, middle	.006
Depth ef ramus at sectorial		.012
Thickness of " "		.007

The affinities of this species are evidently with the *C. cuspigerus.* It is named in honor of Jacob Geismar, a skillful naturalist of Philadelphia.

MACHÆRODUS STRIGIDENS, sp. nov.

This obviously distinct species is only represented by the crown of a superior canine tooth, from which the apex has been broken. Its characters are so peculiar that I record it under the above name, not knowing whether I shall have better specimens.

The tooth is long and very much compressed, much more so than in any species of the genus known to me. Its anterior and posterior edges are finely and very perfectly denticulate without lateral flexure near the base. The centre of each side of the tooth is occupied by a wide open gutter, so that the greatest transverse diameter of the crown is not at its middle. These gutters become planes towards the apex, giving an elongated hexagonal section. The size indicates an animal of the proportions of the *M. primævus,* and smaller than the *M. brachyops.*

As compared with the superior canine of the *Daptophilus squalidens*, which the present specimen resembles in its compression and fine denticulation, it differs in its greater relative length and in the presence of the lateral open sulci.

Measurements.

			M.
Diameter at base	antero-posterior		.0120
	transverse	greatest	.0036
		median	.0032
Length of a denticle on base			.000143

MACHÆRODUS BRACHYOPS, sp. nov.

This species, which ranged in size from that of the puma to that of the jaguar, is represented in my collection by parts of two crania ; by an entire cranium ; by a left mandibular ramus with parts of the skeleton, and by several isolated teeth. The characteristics of the molars in both jaws are those of the other species of this genus. The first superior premolar is two-rooted and small, occupying the middle of the short space between the canine and the second premolar. The latter is large, and has no anterior basal tubercles. Sectorial without anterior basal tubercle. Tubercular tooth small, transverse.

The crania of the three individuals mentioned agree in many particulars; and especially in the very short face and muzzle. This may be more exactly expressed by comparing the interspace separating the second and third premolar from the canine with the length of the base of the latter. From this it is seen that the two dimensions are equal, while in the *M. primævus* the first mentioned is much the longer of the two. In the mandible referred to this species another character is seen in the relatively large size of the premolars, which much exceeds that of the corresponding teeth in *M. primævus.* The first is stated by Leidy to have an anterior basal cusp, which is wanting in the *M. brachyops.*

In the first cranium the sagittal crest is well developed. The canine tooth has an oval section at the base of the crown, whose long diameter somewhat exceeds the distance between it and the anterior base of the second premolar. The infraorbital foramen is large. The second specimen, the left maxillary and part of malar bones with teeth, shows that the length of the base of the sectorial tooth equals the space between it and the middle of the first premolar. The superior aspect of the proximal portion of the malar bone is horizontal, constituting a surface not seen in the species of *Felis.* The canine is robust, with an oval section at the base. The posterior denticulate cutting edge extends higher up than the anterior, and ceases at the base of the enamel. The anterior cutting edge is on the inner side of the anterior face of the tooth.

Measurements.

		No. 1. M.
Length of muzzle in front of canine		.017
Diameter of canine at base	antero-posterior	.018
	transverse	.011
Distance from canine to p. M. 2		.017

Measurements.

No. 2:	M.
Length of base of series to canine	.062
" " second premolar	.018
" " sectorial	.025
Elevation to summit of infraorbital foramen	.033

The characters displayed by the second cranium lead me to suspect that it is that of a female. A striking feature of the superior dental series is the small size of the canine, which is also not much compressed at the base. As regards the cranium, the sagittal crest is only distinct over the posterior part of the brain case ; the zygomata are not very widely expanded, and the muzzle is narrowed. The external infraorbital foramen is large.

The mental border of the mandibular ramus is not flared downwards but is continuous, but the external is separated from the anterior and inferior faces by strong angles. The diastema is long. Three molars, all large ; the first without anterior basal tubercle, the second with a large one. Sectorial tooth the longest, with well developed simple cutting heel.

Measurements.	M.
Total length of cranium	.192
Greatest width "	.123
Length of dental series with canine	.077
Diameter of canine at base { antero-posterior	.012
{ transverse	.008
Distance between canine and second premolar	.019
Length base second premolar	.019
Length base sectorial	.023
Length inferior dental series, with canine	.094
" diastema	.025
Length base of first premolar	.015
" " sectorial	.027
Depth of ramus below second premolar	.032
" " superior canine	.027

This sabre-toothed tiger is larger than the *Machœrodus primævus*, and is more like the animal indicated by a fragment of the lower jaw named by Leidy, *M. occidentalis*. But the latter agrees with the *M. primævus* in the relatively small size of teeth, especially of the first premolar, and in their oblique position, characters not seen in *M. brachyops*.

Perissodactyla.

Anchitherium equiceps, sp. nov.

This animal is represented by a portion of the skeleton including a complete cranium of one individual with mandibular rami of several others. The characters of the species are well marked, and do not approach very nearly to those of any other known to me.

The skull is considerably larger than that of *A. bairdi*, and the length

is greater as compared to the transverse and vertical diameters. The preorbital region is but little concave, and the anterior border of the orbit is above the posterior half of the first true molar. The molar teeth present a tubercle between the anterior lobes, and a weak cingulum extends round the inner base of the anterior one, and in the second premolar, round the base of both inner lobes. Thence it passes round the anterior base of the crown and ceases in a tubercle which rises in contact with the anterior median crest. On the posterior side of the crown the cingulum in like manner terminates in the large three-sided posterior marginal tubercle. The anterior median tubercle-crest is well distinguished from the anterior inner tubercle and is directed very obliquely. The posterior median crest is continuous with the inner, and is well separated from the external crests. The external basal cingulum is robust, the columns are prominent, and the outer faces of the external crescents deeply impressed but with a well marked median ridge. The external cingulum and its margins is rugose; other parts of the enamel smooth. The first premolar has two roots; the second premolar is as long as the fourth, and longer than the last true molar.

Measurements.

		M
Total length of cranium		.280
Length of dental series to first incisor		.147
" " " canine		.130
" molar "		.100
" premolars		.053
" second premolar		.015
Width of " "		.015
Diameter first true molar	antero-posterior	.0135
	transverse	.0165
Diameter of last true molar	antero-posterior	.0135
	transverse	.0170

From *A. condoni* Leidy, this species differs materially in the composition of the superior molars In that species there are no inner tubercle and cingulum; the anterior median crest is more completely separated; the anterior cingulum does not cease with the anterior marginal tubercle, and the posterior marginal tubercle is linear, not trihedral.

ANCHITHERIUM BRACHYLOPHUM, sp. nov.

Portions of the maxillary bones supporting molar teeth, indicate a species of the size of the *A. equiceps*, but differing in various respects.

The median and inner tubercles are not deeply separated, and the former are cut off from the external crescents by a deep fissure. There is no tubercle between the bases of the inner cones, nor is there any internal cingulum. The anterior cingulum does not develop a distinct tubercle, and does not extend to the anterior extremity of the anterior outer crescent. The posterior cingulum develops a large trihedral tubercle, and then extends nearly to the external crescent. The external cingulum is

robust, and the external columns are prominent; the intervening spaces are impressed, and have a distinct median ridge. Enamel smooth or slightly rugose at base of crown.

Measurements. M.

Length of two superior molars		.030
Diameter of first superior molar	antero-posterior	.015
	transverse	.017

These dimensions are those of the *A. equiceps.*

ANCHITHERIUM LONGICRISTIS, sp. nov.

This is a smaller species than the two above described, having the dimensions of the *A. bairdi.* The best specimen representing it consists of a right maxillary bone, which supports all the molars excepting the last. The infraorbital foramen issues above the third premolar. The first premolar is two-rooted; the second is not elongate, and is equal to the other premolars, or the penultimate true molar, in antero-posterior diameter. There are no interior basal tubercles or cingula, but the anterior cingulum has a tubercle which is appressed closely to the anterior median. The posterior cingulum expands into a large trihedral posterior marginal tubercle. The anterior median tubercle-crest, appears in the worn state to be moderately distinct from the internal; both it and the posterior middle are characterized by their production outwards; the latter passing between the exterior crescents and forming a junction with their common connection. The external cingula are not strongly marked, nor the external faces of the crescents impressed; the latter are convex, and with the median ridge little distinct. Enamel smooth.

Measurements. M.

Length of anterior six molars		.062
" premolar series		.044
Diameter of second premolar	antero-posterior	.013
	transverse	.014
Diameter of second true molar	antero-posterior	.0125
	transverse	.0165

In the Annual Report of the U. S. Geol. Surv. Terrs. for 1873,* I gave the comparative characters of the three species of this genus then known to me, viz.: *A. bairdi* Leidy; *A. cuneatum* Cope, and *A. exoletum* Cope. I now give a table in which the three species above described are introduced, with the *A. condoni* Leidy.

A A tubercle between the internal lobes of the superior molars.

Larger; median tubercles well separated; large anterior and posterior marginal tubercles.................................... *A. equiceps.*

Smaller; median tubercles not separated; no anterior marginal and a small posterior marginal tubercle.................................... *A. bairdi.*

AA No tubercle between inner lobes.

* Page 496.

i. External cingulum robust.

β Anterior median crest little or not distinct.

Larger; median crests cut off externally; no anterior marginal tubercle; external faces impressed. .... *A. brachylophum.*

Small; posterior median crest confluent with external crests; an anterior marginal tubercle; external face little impressed....... *A. longicristis.*

ββ Anterior median crest isolated.

Larger; a large anterior marginal tubercle; posterior marginal linear; wrinkled. .... *A. condoni.*

Small; anterior marginal tubercle minute, posterior triangular; median crests short; smooth.................................. *A. cuneatum.*

ii. External cingulum narrow.

External faces without median rib; median crests short, the anterior cut off; marginal tubercles small. .... *A. exoletum.*

Stylonus seversus, gen. et sp. nov.

Gen. Char. These are derived from superior molar teeth *Stylonus* is allied to *Hippotherium* in details, including the isolation of the anterior internal enamel covered column, which thus forms an island of dentine, and in the prismatic character of the tooth. It differs from it in the fact that the posterior internal column is isolated in the same manner as the anterior, thus forming a second island on the triturating surface of the crown.

This interesting new genus adds one to the already numerous forms of extinct equine animals. It carries to its limit the line of development which retains the inner tubercles of the molar crown distinct from the median. The preceding station on this line which we know is the genus *Anchippus,* where the median crests have not assumed the antero-posterior direction belonging to the higher equine genera, and where the molars have short crowns and long roots. We may then believe that the line which includes *Anchippus, Hippotherium,* and *Stylonus,* is a side branch from that which terminated in *Equus.* The line of *Equus* must be traced from *Anchitherium* through *Protohippus* and *Hippidium.*

Specif. Char. Two superior molar teeth were accompanied by a number of inferior molars as having been all found together, but whether they belong to one individual is uncertain. The dentinal lakes of the superior molar are confluent by the median transverse valley, and increased wear would probably join the posterior pair by their posterior angles. The borders of the cementum lakes are simple, except one or two plications on their opposed adjacent borders, and one at the posterior inner part of the posterior. The internal columns are small, and their sections form two equal ovals with their long axes antero-posterior. The anterior dentinal lake sends off a narrow loop towards the posterior part of the anterior column. The shaft of the tooth is incurved, and the external face is unequally divided by the usual ridge. The wide gutters on each side of the latter are uniformly concave, and contain a rather shallow deposit of cementum.

In the inferior molars the two median interior tubercles are stout, and the loops which they bound, are nearly enclosed. There is a tubercle between the bases of the external columns.

Measurements.		M.
Length of crown of superior molar		.028
Diameter superior molar	antero-posterior	.018
	transverse	.016
Long diameter internal column-lake		.005

From the Pliocene formation of Cottonwood, Grant co., Oregon.

DÆODON SHOSHONENSIS, gen. et sp. nov.

Gen. Char. These are indicated by the terminal portion of the lower jaw of a huge mammal, which does not resemble that of any known genus of this order. It supports on the side, three incisors, one canine, and two premolars, which form an uninterrupted series. The first premolar has two roots; and the canine is of huge proportions. The mandibular symphysis is coössified, and there are no osseous tuberosities on it nor on the adjacent parts of the rami.

The characters of the piece on which this genus is established indicate that the latter probably pertains to the *Chalicotheriidæ* along with *Menodus* and *Symborodon.* From these its six inferior incisors distinguish it, while the absence of a diastema separates it from *Chalicotherium.* From *Palæosyops* and *Limnohyus* it may be known by the large two-rooted first premolar, or more correctly, in all probability, by the absence of the first premolar of the inferior series. In the relatively powerful canines it resembles the last named rather than the first named genera.

Specif. Char. The canine teeth are very robust, as in the species of *Elotherium.* The inferior face of the symphysis is not steeply inclined. and is quite elongate. It is narrowed near the bifurcation and expands to a rounded incisive border. The first incisor is narrower than the second and third, which are robust. There are two small mental foramina, the larger below the anterior root of the anterior premolar; the second below the anterior root of the second premolar.

Measurements.		M.
Length of symphysis above		.155
Width between bases of canines		.100
Antero-posterior diameter of base of canine		.055
Transverse " "	second incisor	.022
Diameter of base of first premolar	antero-posterior	.040
	transverse	.025

This species is the largest of the North American *Perissodactyla,* with the possible exception of the *Menodus proutii.*

ARTIODACTYLA.

HYOPOTAMUS GUYOTIANUS, sp. nov.

This species of a genus little known in North America, is represented by

a portion of the left mandibular ramus, in which only the last molar is sufficiently well preserved for identification. The latter is, however, perfect, and furnishes clear evidence of the former existence on the west side of the Rocky Mountains of a species distinct from the *H. americanus* Leidy from the more eastern regions. The cones are in pairs and are directly opposed ; their section is sub-trihedral, the two external sides of the external cones, forming a regular convexity. The cusps are acutely produced and slightly divergent. The posterior side of each outer cusp is excavated ; the exterior side of the same presents a median rib with a con cavity on each side, which is terminated below by an imperfect cingulum. The latter terminates on each side of the base of the cusp in a rudimental cusp, of which there are thus four on the external side of the tooth. The boundaries of the inner face of the external cusps are angular ; the posterior one joins a corresponding ridge from the inner cusps, but there is no descending ridge on the anterior inner side of the internal cusp, which therefore forms no junction with the opposite part of the external cusp. The fifth cusp is well developed, and sends a crest inwards to the interior base of the interior cusp of the adjacent pair.

Measurements.		M.
Diameter of last inferior molar	antero-posterior........	.022
	transverse............	.010

This species is smaller than the *H. americanus,* and differs much in details. It is dedicated to Prof. Arnold Guyot, of Princeton, New Jersey.

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SECOND CONTRIBUTION

TO A

KNOWLEDGE OF THE MIOCENE FAUNA

OF OREGON.

BY E. D. COPE.

(Read before the American Philosophical Society, Dec. 5, 1879.)

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PHILADELPHIA.

Second Contribution to a Knowledge of the Miocene Fauna of Oregon. By E. D. Cope.

(Read before the American Philosophical Society, December 5, 1879.)

Two contributions to the present subject have been heretofore made by the writer, viz., in the Proceedings of the American Philosophical Society, for November, 1878; and in the Bulletin of the U. S. Geological Survey of the Territories for February, 1879. In the latter article thirty-eight species of vertebrata were enumerated as having been discovered in the Truckee beds of the White River formation of Oregon, of which all but one were mammalia.

I have since conducted explorations in that region, the expeditions being mostly under the direction of Jacob L. Wortman. This gentleman has obtained a great many specimens, several of which indicate new species, which it is the object of the present article to describe. In addition to these discoveries, Mr. Wortman has sent remains of *Lacertilia* and *Ophidia*, orders previously unknown in Oregon. I had discovered them in the White River formation in Colorado in 1873.

HESPEROMYS NEMATODON, sp. nov.

This rat is represented by a beautiful skull, discovered by Prof. Thomas Condon, of Eugene city, and by several jaws, and other fragments subsequently found by Mr. Wortman.

The frontal region is not contracted as in *Eumys elegans* and *Fiber zibethicus*, but the superciliary ridges are well separated from each other, as in *Hesperomys americanus*. The frontal and posterior nasal regions are slightly concave in transverse section. The molars display tubercles on one side, and crescents on the other, the former being external in the superior series. The first superior molar has an additional tubercle at its anterior extremity. The incisors have a transverse anterior face, which is divided by several delicate ridges.

Length of superior molar series, .0065; length of first superior molar, .0028; interorbital width, .0042. Length of inferior molar series (specimen No. 2), .0064; length of first molar, .002; width of incisor, .001; depth of ramus at second molar, .004.

SCIURUS VORTMANI, sp. nov.

Like the *S. relictus*, of the Colorado White River beds, this is a rare species, being only represented by a mandibular ramus in my collection. This part is remarkable for its depth as compared with its length; and the base of the coronoid process has an anterior position. It rises opposite the posterior part of the third molar, and its anterior border descends to a point just below the posterior part of the first molar. The inferior border of the masseteric fossa is a prominent edge, which descends below the inner inferior margin of the ramus. The molars diminish regularly in size forwards; their crowns are basin-shaped, with the anterior angle of the ex-

ternal border elevated, and the inner border notched medially. Incisor compressed.

Length of inferior molar series, .010 ; antero-posterior diameter of first molar, .0024 ; length of fourth molar, .003 ; depth of ramus at diastema, .0055 ; depth at third molar, .0095.

This species is considerably larger than the *S. relictus*. It is dedicated to Jacob L. Wortman, of Eugene, Oregon, a successful explorer of the paleontology of that State.

PACICULUS INSOLITUS, gen. et sp. nov.

Char. gen. Superior molars three, rooted. Enamel forming three entrant loops on the external face of the crown, and one on the internal face.

While the number of the superior molars of *Paciculus* is as in the *Muridæ*, the details of their structure is much as in *Dasyprocta* and *Steneofiber*. But one species is known.

Char. spec. Size small. Molars regularly and rapidly diminishing in size posteriorly. Inner enamel loop turned forwards ; the external straight and transverse, excepting in the first molar, where the anterior column of the tooth is extended forwards, and the anterior loop is turned backwards.

Length of superior molar series, .006 ; length of first molar, .0021 ; width of first molar, .0018 ; length of third molar, .001.

CANIS LEMUR, sp. nov.

This species is represented by several crania in my possession. It is the smallest of the genus yet discovered in the Miocene formation of Oregon. It is characterized by the contracted proportions of the muzzle, the width of the front, and the large size of the eyes. The postorbital process is only a short angle. The superior border of the temporal fossa is traceable from the postorbital process. Those of opposite sides embrace a smooth sagittal area of an elongate urceolate form, and unite posteriorly in a very short crest. The species is further characterized by the large size of the first superior tubercular molar, which with the second, has a distinct inner cingular border, and median tubercle. The superior sectorial is short, and its inner cusp is anterior.

Some mandibles probably belonging to this species exhibit posterior cutting lobes on the third and fourth premolars. The blades of the sectorial are very short, and the heel large and wide. The tubercles of the tubercular are large.

Length of cranium to front border of orbit, M. .0525 ; elevation of occiput, .058 ; length of superior sectorial, .007 ; length of first tubercular, .0058 ; width of first tubercular, .0078 ; width of second tubercular, .005 ; length of second tubercular, .0035 ; interorbital width of second specimen, .0056 ; length of inferior dental series, .048 ; length of sectorial, .008 ; length of heel of sectorial, .0035 ; length of inferior tubercular, .055 ; depth of ramus at sectorial, .0105.

This species is smaller than *Canis gregarius*, and differs from both it and the C. *cuspigerus* in the larger orbits, more contracted muzzle, and in the distinct superior border of the temporal fossa, etc.

The dog which I referred to the genus *Enhydrocyon* (Cope) under the name of *E. basilatus*, probably belongs to another genus. Portions of the maxillary bone present the dentition of *Icticyon*, viz., P-m. 4, M. 1, thus differing from *Enhydrocyon*, which possesses P-m. 3; M. 2. As there are but three premolars in the inferior series, this species cannot be referred to *Icticyon*, but must be accepted as typical of a new genus. This I propose to call *Hyænocyon*. It resembles *Hyæna* more nearly than any genus yet discovered in North America, but probably belongs to the *Canidæ*.

AMPHICYON ENTOPTYCHI, sp. nov.

This rather small species is represented by a skull which lacks the extremity of the muzzle and the mandible, and has its parietal region crushed.

The superior premolar teeth are rather short in anteroposterior diameter, while the tubercular molars are relatively large. There are no posterior lobes on the former; the internal and external cingula are well developed in the first and second of the latter. The third tubercular is about as wide as the second is long. The sagittal crest is only distinct on the posterior part of the parietal region. Estimated length of skull, M. .110; length of superior molar series, .041; length of true molar series, .016; length of first tubercular, .0075; length of second tubercular, .055; width of second tubercular, .0074; length of third tubercular, .0036; width of third tubercular, .052: Length of sectorial width between anterior external angles of first tuberculars, .030.

The teeth of this species are about half the size of those of *A. vetus* Leidy.

ARCHÆLURUS DEBILIS Cope.

American Naturalist, 1879, p. 798*a*, December.

Char. gen. Dentition, I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{3}$; M. $\frac{1}{2}$; mandible with the anterior face of the symphysis separated from the lateral face by an angle which is not produced downwards. Superior sectorial without anterior lobe; inferior sectorial with heel. The characters place *Archælurus* at the base of the *Felidæ*, showing that it is the most generalized form yet known, and about equally related to the feline and Machærodont series.

Char. specif. General structure of the jaws weak. Superior canine small, little compressed, with an acute posterior edge which is not serrulate. First premolar in each jaw one-rooted; second inferior premolar large; sectorials large, diastemata very short. Alveolar border below the inferior sectorial and tubercular teeth everted, forming a large osseous callus, which has a free inferior and posterior margin, the latter rising into the base of the coronoid process. Zygomata slender; postorbital processes little prominent; front wide, convex transversely.

Length of cranium, M. .200; superciliary width, .052; zygomatic width, .124; length from orbit to superior incisors, .066; length of superior sectorial, .023; length of inferior molar series, .064; diameter of superior canine, .012. About the size of the panther, or of the *Nimravus brachyops*.

The osseous callus below the true molars is a remarkable character, unique in the order of *Carnivora*. It is evidently a provision against the weakness of the mandibular rami, at the point of greatest strain.

HOPLOPHONEUS PLATYCOPIS Cope.

American Naturalist, 1879, p. 798*b*, December.

This is the largest sabre tooth discovered in North America. It was twice the bulk of the *H. primævus* Leidy, and differs from that species and the *H. occidentalis* in the relatively larger size of the premolar teeth, which are less obliquely placed than in the latter. The first superior premolar is very small. The canine is large and compressed as in the species of *Machærodus*, and has serrulate posterior and anterior cutting edges. Inferior incisors with conic crowns. The symphysis is very deep in consequence of the large development of the inferior flares for the canines. Sagittal crest making a steep angle with the front.

Total length of cranium, M., .280 ; zygomatic width, .192 ; length from orbit to superior incisors, .095 ; length of inferior sectorial, .025 ; of inferior sectorial, .022 ; length of inferior molar series, .055 ; length of crown of superior canine, .060 ; width of superior canine at base, .026. This skull is less than one-sixth smaller than that of the Bengal tiger (*Uncia tigris*).

CHÆNOHYUS DECEDENS, gen. et sp. nov.

The characters of this genus will be best understood by comparison with those of the two other genera of suilline animals which occur in the same formations.

Premolars three, a wide diastema between the anterior one and its successor.. *Chænohyus.*

Premolars four ; diastemata before and behind the first ... *Thinohyus.*

Premolars four, in a continuous series.................... *Palæochærus.*

It is then apparent that *Chænohyus* differs from *Dicotyles* in having the diastema behind the anterior premolar instead of in front of it.

Char. spec. This hog is represented in the collection of Prof. Condon at Eugene City, Oregon, by the anterior part of a cranium, which includes both maxillary bones. Its size is a little less than that of the *Dicotyles torquatus.* The series of maxillary teeth is slightly convex externally, and the teeth diminish rapidly in size anteriorly. The difference in dimensions between the first and last true molars is much greater than in the other suillines of this period known to me. The external tubercles of the true molars are somewhat flattened externally, and a distinct cingulum passes entirely round their external bases. The first superior premolar has one root, the other premolars possess two.

I suspect that the *Dicotyles hesperius* of Marsh belongs to *Chænohyus.* It differs from the *C. decedens* in its materially smaller size. According to Marsh, it is considerably smaller than his *Thinohyus socialis,* which is about as large as the *C. decedens.*

Discovered by Prof. Condon in the region of the John Day river.

THINOHYUS TRICHÆNUS, sp. nov.

Represented by the greater part of the maxillary and mandibular bones of both sides, with teeth.

There is a diastema behind the second inferior premolar, about equal in

extent to that in front of it, which is twice as wide as the one in front of the first premolar. The first and second premolars have but one root, while the two others have two. The first superior premolar is close to the canine, and has but one root; it is separated by a diastema from the second. The latter has one root, and is near the third, which has two roots. The third and fourth superior premolars have each one compressed external, and one internal lobe. That of the third is lower and is pressed against the external. It is continued as a ridge posteriorly, enclosing a shallow basin with the external tubercle.

The true molars of both jaws have the intermediate tubercles well developed. The external tubercles of the superior molars are not flattened, and have a low cingulum surrounding their bases. Surface of enamel nearly smooth. Length of true molar series of upper jaw, M. .046; of last superior molar, .017; width of do., .013. Diameter of first true molar,—anteroposterior, .012; transverse, .011. Length of posterior three premolars along base, .028; of diastema, .011. Length from inferior canine to third inferior premolar, .028; length of diastema anterior to second premolar, .008; do. of diastema posterior to second premolar, .007.

This is the species I formerly called *Palæochœrus condoni** Marsh (*Platygonus* Marsh). That species belongs to the Loup Fork fauna, and not to the present one. Some teeth which probably pertain to it in Prof. Condon's collection, exhibit the peculiarity of not possessing any basal cingula on the molars of either jaw.

From the fact that Pomel† implies that some of the species of *Palæochœrus* present a diastema, I have referred the *Thinohyus* of Marsh to it as a synonym.‡ Pomel's genus was, however, established on a species (*P. typus*) which has no diastema, hence *Thinohyus* is probably to be preserved.

This species is about the size of the *Thinohyus lentus* of Marsh, and agrees with his descriptions in several respects. There appears, however, to be a material difference between the specimens in the relations of the inferior premolars. Marsh describes a much more considerable diastema in front of the first premolar, and does not mention the one behind the second premolar. I am acquainted with a second species of the genus of about the same size, in which there are but two diastemata, viz., one before and one behind the first premolar, and I suppose this one to resemble the *T. lentus*. Specimens of this character are in my collection, and I have seen one in that of Prof. Condon.

PALÆOCHŒRUS SUBÆQUANS, sp. nov.

This suilline is represented by an entire cranium which was discovered by Prof. Condon. It indicates a species of the size of the *Dicotyles torquatus*, and smaller than the *Thinohyus trichænus*.

The first true molar is not disproportionately smaller than the third; and there is a distinct cingulum at the external base of the superior true molars.

* Bull. U. S. Geol. Surv. Terrs., 1879, V, p. 58.
† Catal. Vertebr. Foss. Basin Loire, 1853, p. 86.
‡ Bull. U. S. Geol. Surv. Terrs., 1879, V, p. 44.

The external faces of the external tubercles of these teeth are somewhat flattened. The first premolar has one root, the others have two. They are equidistant and not very closely crowded.

Several suillines are described by Marsh and Leidy, either imperfectly or from imperfect material, so that I have had some difficulty in determining my specimens. The *D. hesperius* of Marsh is probably, as above observed, a *Chænohyus.* I have specimens agreeing with Marsh's description of *Thinohyus socialis.* They belong to an animal of the size of the *Chænohyus decedens,* but the superior molars have no basal cingulum. Its generic position is yet uncertain. Other specimens agree in characters with the *Dicotyles pristinus* of Leidy, with which *Thinohyus lentus* of Marsh agrees in size. In this hog there is no diastema in front of the third inferior premolar, so that it is clearly distinct from the *Thinohyus trichænus* of the present paper.

MERYCOPATER GUIOTIANUS Cope.

Having obtained several crania of this species, I can give the characters of the genus *Merycopater** more fully than hitherto. Dentition ; I. $\frac{1-2}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$. A diastema above and below ; fourth superior premolar with two external crescents ; fourth inferior premolar identical in form with first true molar ; the first inferior premolar functionally the canine. Orbit open posteriorly; no facial fossæ or vacuities.

This genus is *Agriochœrus,* with a considerable diastema, and very much reduced superior premaxillary teeth. In my best preserved cranium there is no alveolus for the first ; that of the second is rudimental, and that of the third is small. The premaxillary bones are very small and distinct from each other. The enlargement of the cingula represents the posterior internal tubercle of the fourth superior premolar, so distinct in *Coloreodon.*

The deficiency in superior incisors is an interesting approximation to true ruminants not heretofore observed in *Oreodontidæ.* I have found the inferior incisors deficient in the genera *Cyclopidius* and *Pithecistes.*

COLOREODON FEROX, gen. et sp nov.

Char. gen. Dentition, I. ? ; C. ^{1} ; P-m. ^{3} ; M. ^{3} ; a wide diastema above ; the first inferior premolar functionally the canine. Last superior premolars with two external and two internal crests Orbit open posteriorly ; no facial fossæ or vacuities. The genus differs from *Agriochœrus* in the wide diastemata, presence of but three superior premolars, and two inner tubercles of the fourth premolar.

I possess two species of this new genus, which are represented in my collection by crania without premaxillary bones and mandibles.

Char. specif. Size of *Oreodon culbertsoni.* Maxillary bone excavated above the diastema, the superior border of the concavity extending nearly to the base of the zygoma. Zygomatic arches expanded, their external face concave below the orbit, and plane posteriorly. Saggittal crest very high, dividing anteriorly into two ridges, which diverge widely, and

* Cope, *American Naturalist,* 1879, p. 197.

terminate at a point opposite the postfrontal process. The space enclosed in their angle is plane. Space between supraorbital foramina convex.

The posterior internal tubercle of the fourth premolar is much smaller than the anterior; the inner basal tubercles of the second and third are subposterior and acute. The length of the diastema is equal to that of the premolar series. The enamel of the molars is wrinkled. The canines are robust.

Estimated length of skull, M. .200; length of superior molar series, .066; of diastema, .028; diameters of second true molar, — anteroposterior, .016, transverse, .017; width of palate at do., .033; interorbital width, .060.

The strongly developed crests and wide zygomata of this animal, together with the large canine teeth, evidently indicate that it was a formidable antagonist even for the *Carnivora* of its time.

Discovered by Charles H. Sternberg.

COLOREODON MACROCEPHALUS, sp. nov.

This Oreodont is considerably larger than the *C. ferox*, being of the size of the *Eucrotaphus major*, while the former equals the *Oreodon culbertsoni*. It also differs from its congener in the relatively longer and narrower frontal region. The sagittal crest is elevated, and divided into two crests opposite the posterior part of the zygomatic fossa. These branches are nearly straight, and diverge at an acute angle, terminating above the postorbital processes. They enclose a deep concavity, which is continuous with the front anteriorly. In *C. ferox* these crests diverge much more abruptly and widely from a more anterior point, and enclose a much smaller concavity. The supraorbital foramina are close together and are separated by a small protuberance of the middle line. The parietal walls of the temporal fossa are rugose. The posterior tubercle of the fourth premolar is well developed, while a single tubercle is present on the preceding premolar.

Length of cranium from inion to above superior canine, M. .230; length from superior canine postorbital angle (axial), .124; length from junction of crests to supraorbital foramina, .060; interorbital width, .072; length of bases of the molars except the last, .050; length of three premolars .027. Length of diastema, .030.

From the North Fork of John Day River; found by J. L. Wortman.

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Paleontological Bulletin, No. 32.

SECOND CONTRIBUTION

TO THE

History of the Vertebrata

OF THE

PERMIAN FORMATION OF TEXAS.

BY E. D. COPE.

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PALEONTOLOGICAL BULLETIN, No. 32.

*Second Contribution to the History of the Vertebrata of the Permian Formation of Texas. By E. D. Cope.**

(*Read before the American Philosophical Society, May* 7, 1880.)

Since my synopsis of this subject, published in May, 1878, the accession of much new material had enabled me to make a number of important additions to it. Notes which record some of these may be found in the American Naturalist for September and December, 1878, and for April and May, 1880. The substance of these is included in the present essay.

At the meeting of the National Academy of Sciences, held in New York, in November, 1878, I pointed out that the scapular arch in the *Pelycosauria*† consists of scapula, coracoid and epicoracoid, which form a continuum in the adult, in the same way as the three elements of the pelvis in the same group form an os innominatum. The tibiale and centrale of the tarsus unite to form an astragalus which has no movement on the tibia. The fibulare forms a calcaneum. The distal side of the astragalus presents two faces, one of which receives a large part of the proximal extremity of the cuboid.

The structure of the scapular and pelvic arches is identical with that already described by Owen as belonging to the *Anomodontia.* Several important characters distinguish this group from the *Pelycosauria,* but the two together form an order which I have thought must, for the present at least, be retained as distinct from the *Rhynchocephalia.* The characters of this order, with its two sub-orders, are as follows:

THEROMORPHA Cope. Scapular arch consisting at least of scapula, coracoid and epicoracoid, which are closely united. Pelvic arch consisting of the usual three elements, which are united throughout, closing the obturator foramen and acetabulum. Limbs with the phalanges as in the ambulatory types. Quadrate bone proximally united by suture with the adjacent elements. No quadratojugal arch.

Pelycosauria. Two or three sacral vertebræ; centra notochordal; intercentra usually present. Dentition full.

Anomodontia. Four or five sacral vetebræ; centra not notochordal; no intercentra. Dentition very imperfect or wanting.

The *Rhynchocephalia* have no distal ischio-pubic symphysis, and apparently no epicoracoid bone. They have an obturator foramen, and a quadratojugal arch.

The order *Theromorpha* approximates the *Mammalia* more closely than any other division of *Reptilia.* This approximation is seen in the scapular arch and humerus, which nearly resemble those of the *Monotremata,* especially *Echidna;* and in the pelvic arch, which Owen has shown in the sub-order *Anomodontia* to resemble that of the Mammals, and as I have

* Abstract read before the National Academy of Sciences, April 20, 1880.

† See Proceed. Amer. Philos. Soc., 1878, p. 511 and 528.

pointed out, especially that of *Echidna.* The tarsus is also more mammalian than in any other division of reptiles. In the genus *Dimetrodon* the coracoid is smaller than the epicoracoid, as in Monotremes. The pubis has the foramen for the internal femoral artery.

A not less remarkable characteristic of the *Pelycosauria,* as represented by *Clepsydrops* and *Dimetrodon,* is their resemblance to the *Batrachia* in some important respects. This is seen in the scapular and pelvic arches, which resemble very much those of the *Urodela,* and of such types as *Eryops.* The small coössified coracoid only differs from that of *Eryops* in having two deep sinuses of its free border. The general form of the pelvis is similar, but the ilium has a special and peculiar articular face for the sacral diapophysis, which is wanting in *Eryops.* In the inferior arches, the absence of obturator foramen, and general boat-like form, are the same in both; but in the *Pelycosauria* the symphysis is not so deep, and the walls less massive. But the resemblance of these arches to those of the *Batrachia* in question is greater than to those of any order of reptiles.

Another point of resemblance to the *Batrachia* is seen in the humerus. In my previous essay on the *Pelycosauria* above cited, I defined six types of humerus as occurring in the Texas Permian. Two of these were described as wanting the foramen,* while the others were stated to possess it; other differences between these types exist, but they were not mentioned. Since then Gaudry has added a third form to the former group, which he has ascribed to a reptile under the name of *Euchirosaurus.* I have detected this form in my Texas collections together with another, which has no condyles at either extremity. Thus eight forms of humerus are found in this formation.

That the type with the supracondylar foramen belongs to the *Pelycosauria* has been satisfactorily shown by its presence in the skeleton of *Clepsydrops natalis* and in *Cynodraco major,* where Owen first identified it. I find the type without this foramen frequently associated with the skeletons of *Eryops,* and other *Stegocephali.* There is no other element that can be regarded as the humerus of this type. It moreover has distinct points of resemblance to the humerus of existing *Batrachia,* parallel with similarity traceable in the femora of the extinct and recent genera. There is then every reason for believing that we have in the humerus of *Eryops* and its allies, an element which approaches closely in its characters to that of the *Pelycosauria,* and hence to that of the *Monotremata.*

There are some other peculiarities which constitute resemblances of the same kind. The tooth bearing elements of the roof of the mouth have batrachian character. Such is the densely packed body of teeth seen in *Dimetrodon;* and so are the teeth on the vomer in *Empedocles.* There is also a possible existence of epiphyses, judging from various specimens of humeri in my possession of both *Pelycosauria* and Stegocephalous forms.

In spite of these approximations, the *Pelycosauria* are distinctively rep-

* This word was misprinted "fossa" l. c. p. 529.

tilian in their single occipital condyle, ossification of the basicranial cartilage, and single vomer.

Thus the reptiles and batrachia of the Permian period resembled each other and the *Mammalia*, more closely than do the corresponding existing forms.

PELYCOSAURIA.

THEROPLEURA Cope.

Paleontological Bulletin No. 29, May, 1878, p. 519, Proceed. Amer. Philos. Soc., 1878, p. 519.

A more complete specimen of the *Theropleura uniformis* than any hitherto obtained gives the following generic characters.

The teeth are generally similar to those of *Clepsydrops* and *Dimetrodon*, having compressed crowns with fore and aft cutting edges. The incisors are distinguished by the presence of a diastema. Posteriorly to this the teeth increase in size, and then diminish ; one tooth near the middle of the series is the largest, but does not in this species very much exceed the others. There is at least one large incisor tooth. The bones of the head are smooth, and not sculptured ; a character distinguishing the genus from *Ectocynodon*. The symphysis of the mandible is short.

The neural arches of the vertebræ are all distinct from the centra. Intercentra are not present in any of the thirteen vertebræ preserved, but there was probably one below the centrum of the atlas. The ribs are two-headed, the capitular process extending downward to the anterior border of the centrum. The neural spines of some of the vertebræ are greatly elevated as in the species of *Clepsydrops* and *Dimetrodon*. The scapula is long ; the ilium is similar to that of the genera named. A character which has not been detected in either of the genera named is the presence of dermal rods, which from their position adherent to the vertebræ, I suspect to be abdominal, and similar to those of the genus *Oëstocephalus*. This is a batrachian character. The neural spine of the axis is extended fore and aft. The odontoid is distinct and is of large size. It has lateral and inferior articular surfaces.

THEROPLEURA UNIFORMIS Cope.

Paleontological Bulletin No. 29, p. 519, 1878.

This species is about the size of one of the larger *Varanidæ*, and about equal to the *Clepsydrops natalis*. It is characterized by a long and acuminate head, with a large lateral nostril on each side, well forwards, and approaching near the border of the diastema. In the specimen the top of the head is crushed and the postorbital portion is wanting. Anterior to the large lateral tooth there are nine teeth ; posterior to it there are eighteen. The anterior cutting edge of the crown does not extend so near the base as the posterior, and is best marked on the anterior teeth. In the crowns preserved the edges are not serrate.

Measurements.	M.
Length of alveolar edge of mandible	.120
" from diastema to canine tooth	.030
" of centrum of atlas	.010
" " " " axis	.018
" " centra of following five vertebræ	.071
" " ilium at acetabulum	.040

The lanciform shape of the skull with its consequent peculiarities distinguishes this species from the *Clepsydrops natalis*, and the *Dimetrodon incisivus*. The canine tooth is more posterior, the teeth more numerous, and the alveolar borders less curved than in either of those species. The diastema is less excavated, and the muzzle less obtuse.

THEROPLEURA OBTUSIDENS, sp. nov.

This species is represented by nearly all parts of the skeleton, including jaws of both sides with teeth, numerous vertebræ, and bones of the limbs. Many of these pieces are preserved in continuous masses, thus greatly aiding in the identification of parts.

Although the species is not larger than the *Theropleura retroversa*, the neural arches are coössified with the centrum.

The jaws are long and rather slender, and there is no such inequality in the sizes of the maxillary teeth as in the genera *Dimetrodon* and *Clepsydrops*; the canine being scarcely larger than the others. The crowns are elliptical in section at the base, with straight sides; the sections of the crowns are lenticular, and the apices are not very acute. The superficial coating is striate with fifteen or sixteen rather obtuse ridges The cutting edges are not very acute, nor are they denticulate. The number of teeth in the dentary bone cannot be precisely stated, but is about twenty-one.

The mandibular articular face consists of two open parallel grooves, one shorter than the other, extending obliquely to the long axis of the jaw. The palatal dentigerous bone is quite different from that of *Dimetrodon*. Its inferior face instead of being narrow, is rhombic. The ascending process arises from one of the terminal angles of the rhomb, and the horizontal process continues from the opposite angle in line with the inferior surface. The borders of the rhomb next to the ascending process are dentigerous; the one bears a single series of four large teeth; and the adjacent angle and side bear numerous small teeth.

The vertebræ have the elongated neural spines of the allied genera, and they are simple. The centra have curved articular margins indicating the presence of intercentra, which are, however, not preserved. Traces of sutural articulation with the neural arch remain. Many of the centra are much compressed and have a narrow sharp median keel. In a few vertebræ, apparently from the posterior part of the column, an angular ridge extends posteriorly from the base of the diapophysis; this is apparent also on a caudal centrum. This point is characteristic of the *T. retroversa*, but I do not find the large capitular facet of that species in the *T. obtusidens*. The

lateral ridges of *T. triangulata* are situated low down on the centra. The diapophyses supporting the tubercular articulation are frequently elongate.

The scapular and pelvic bones are of the usual type. The humeri belong to form second of my Pal. Bull. No. 29. They have rather slender shafts, and much expanded extremities. The proximal articular surface is well defined. The supracondylar foramen and other points are as in the *Pelycosauria* generally. There were probably distal condyles, but this is not absolutely certain.

Measurements.			M.
Length of mandibular series of teeth (nearly complete), on block			.110
Length of crown of mandibular tooth			.008
Anteroposterior diameter of mandibular tooth			.004
Diameters of articular extremities of a vertebra on the same block	vertical		.021
	transverse		.020
Length of another centrum on same block			.020
Diameters of humerus (separate)	of head	larger	.065
		smaller	.013
	of shaft		.017

The above description represents the parts which belong either certainly or very probably to one individual. Bones of a second and larger animal are mingled with these. The species to which they belong is uncertain, but they resemble very much those of the *Theropleura obtusidens,* and may belong to a larger individual of that species. A femur has the form already described under the head of *Clepsydrops natalis.* (Paleontological Bulletin, No. 29, p. 510.) Some phalanges belonging no doubt to one or the other of the two animals, are like those I have already ascribed to *Clepsydrops.* They are depressed, and are expanded at the articular extremities. The distal extremities expand the most abruptly, and their convex trochlear face is without groove or keel, and is more extended on the inferior than the superior surface.

DIMETRODON Cope.

Proceedings American Philosophical Society, 1878, p. 512.

The accession of a considerable amount of material representing this genus enables me to add important points to our knowledge of its osteology. The most noteworthy additions include the greater part of the skeletons of two individuals of *D. incisivus;* and vertebræ attached to the pelvis and femora of *D. gigas.* There are also vertebræ of several individuals of *D. cruciger,* and various parts of the skull of a species distinct from the *D. incisivus.*

In both specimens of *D. incisivus,* portions of the palatopterygoid arch are attached to the maxillary bone. One of these elements is an oval plate with a thickening of its inferior side, so as to bevel the long border farthest from the maxillary bone. The surface thus produced is thickly studded with small conical teeth irregularly disposed.

A second tooth-bearing element of the palate is adjacent to the last. It

is a massive plate, the ends of which are produced in opposite directions ; the one into a massive shorter prominence ; the other longer and plate-like. Between these prolongations, the inferior edge of the bone bears a single row of well developed teeth. The patch of small teeth first described, commences at the extremity from which the longest process rises on the opposite side of the series of large teeth. This Z-shaped bone is, from its massive character, generally preserved, and I was long familiar with it, before I could refer it to its position. In one specimen, a part of it bearing teeth, adheres to the upper jaw at the diastema.

The posterior part of the skull of one of the specimens above mentioned displays typical reptilian characters. The occipital condyle is not perforated, nor divided by sutures. The exoccipital bones project well backwards. The lateral walls of the brain-case are massive as far forward as the exit of the fifth pair of nerves ; anterior to this point they were thin or wanting. The basisphenoid carries two parallel descending laminæ, which bound a deep median fissure, and then unite anteriorly. Posteriorly they abut on a descending process, which is followed by a lid-like element which is applied to a circular fossa with a raised border near the occipital condyle.

The articular face of the articular bone of the mandible consists of two parallel cotyli, divided by a ridge of articular surface. This part of the jaw is much depressed, as in *Eryops*. The large teeth of the lower jaw are at the anterior extremity.

The neural spine of the axis is flat and elongate antero-posteriorly. From this point the neural spines rise rapidly in elevation until on the dorsal region they are many times as long as the diameters of the centra. The latter are not very unequal in their proportions in different parts of the column. Those from the posterior regions are less compressed than the dorsals and cervicals. The dorsals are separated by intercentra below, which are small in the *D. incisivus*, and larger in the *D. gigas*. All the ribs are two-headed, commencing with the axis. All the crevical and dorsal vertebræ have diapophyses with tubercular facets. The head of the rib is prolonged downwards and forwards to the prominent border of the anterior articular face, against which it abuts, but so far as yet observed, without a corresponding facet. On the caudal vertebræ the two facets of the ribs are approximated and finally are not distinguished. They are here coössified with the centra.

The humerus accompanying one of the specimens of *D. incisivus*, is of the form No. 3, of my description of humeri in the Paleontological Bulletin No. 29, p. 528. The extremities are expanded and the shaft is without diagonal ridge ; the supracondylar foramen is enclosed, and the condyles are robust. The pelvis of the *D. gigas* is in general like that of *Clepsydrops natalis* (l. c., p. 510). The elements are coössified, but the ischiopubic symphysis is not so deep as in the *Batrachia* of the same beds. The ilium is shortened above, and its direction is at right angles to the long axis of the inferior elements The foramen of the internal femoral artery is distinct. The femur of the

same individual of *D. gigas* has no head, but a regular wide crescentic proximal articular surface. Below this on the posterior side is the large trochanteric fossa, which is bounded by lateral ridges, which are at first equal, but one soon exceeds the other in height, forming a trochanteric ridge a little above the middle of the shaft. The condyles are distinct from each other and are flattened below. One of them bears a robust longitudinal crest above, which makes it much larger than the other, and causes the groove that separates them above, to look outward, or to the side which supports the trochanter.

Three of the species may be distinguished as follows:

Vertebral centra much compressed, acute below; neural spines without processes...*D. incisivus.*

Vertebral centra less compressed, obtuse below; neural spines without processes; larger...*D. gigas.*

Vertebral centra compressed, not acute below; neural spines with cross projections...*D. cruciger.*

DIMETRODON CRUCIGER Cope.

American Naturalist, 1878, p. 830.

This species is not uncommon in the Permian Formation of Texas. It is characterized by the enormous length of the neural spines of the lumbar vertebræ, which form the dorsal fin seen in other species of the genus. They are found in masses adhering together like sticks or branches of bushes. In this species the spine sends off, a short distance above the neural canal, a pair of opposite short branches, forming a cross. At various more elevated positions there are given off tuberosities which alternate with each other. They form on several consecutive spines oblique rows. The spines are broadly oval in section, the long axis antero-posterior, and have a shallow groove on both the anterior and posterior aspects. The centra are elongate as compared with their other diameters, and are much compressed between the articular extremities, leaving a strong inferior median obtuse rib. Articular faces of zygapophyses oblique. Diapophyses short and robust, with large costal faces, and standing below the prezygapophyses.

Measurements.		M.
Diameter of centrum	antero-posterior	.043
	vertical at end	.028
	transverse at end	.030
Elevation of posterior zygapophyses above centrum		.025
" cruciform process " "		.058
Expanse of posterior zygapophyses		.034
" cruciform process		.048
Diameter of spine at base	antero-posterior	.030
	transverse	.020
" " .090 above base	antero-posterior	.016
	transverse	.016
Length of several pieces of neural spines		.140

DIADECTIDÆ.

I have obtained three skulls of the *Empedocles molaris*, a species of this family, which display the occiput, and two of them the basis of the cranial and facial regions. From them I derive the following characters.*

The relations of the quadrate and zygomatic arches are as in the *Theromorpha* generally. The pterygoids extend to the quadrates, and the vomer bears teeth. The brain-case extends to between the orbits, and its lateral walls are uninterrupted by fissures from this point to near the origin of the *os quadratum*. There is an enormous frontoparietal foramen. The mode of connection with the atlas is peculiar. There is a plane facet on each side of the *foramen magnum*, which then expands largely below them. The bone which bounds it inferiorly, presents on its posterior edge a median concavity. On each side of this, is a transverse cotylus, much like those of an atlas which are applied to the occipital condyles of the *Mammalia*. They occupy precisely the position of the Mammalian condyles. The median point of their upper border, which forms the floor of the foramen magnum, is produced in the position occupied by the median occipital condyle of a reptile. From its position between the cotyli, the section of this process is triangular. The element in which the cotyli are excavated has the form of the mammalian basioccipital, and of the reptilian sphenoid. It is not the batrachian parasphenoid. Its extreme external border on each side where it joins a crest descending from the exoccipital, is excavated by a circular fossa which looks outwards.

The character of this articulation is so distinct from anything yet known among vertebrated animals, that I felt justified in proposing (l. c., p. 304) a new division of the *Theromorpha* to include the *Diadectidæ*, to be called the *Cotylosauria*. The superior facets described, indicate the presence of atlantal zygapophyses as in the *Ganocephala*.

There are three genera of *Diadectidæ*, one of which is now introduced for the first time. They are distinguished as follows :

I. Molar teeth in one series ;
  A distinct canine.......................... *Diadectes*.
  No canine.. *Empedocles*.
II. Molar teeth in two series ;
  A canine.. *Helodectes*.

I am acquainted with six species of this family, two of each of the genera.

DIADECTES Cope.

Proceeds. Amer. Philos. Society, 1878, p. 505. American Naturalist, April 22, 1878.

The typical species of the genus has compressed teeth, with one end of the crown much more elevated than the other. In the lower jaw the inner extremity is the elevated one, and *vice versa*. There is a large tooth in the position of a canine in the inferior series, but it is not certain whether or not it is an incisor. A new species is now described which is intermediate

*These were first described in the American Naturalist, 1880, p. 304.

between the *D. sideropelicus* and the *Empedocles molaris* in the form of the molar teeth. The species are distinguished as follows :

Much inequality in the elevation of the extremities of the molars ; lower tubercle small .... *D. sideropelicus.*

Extremities of molars not very unequal in height ; lower tubercle large.. *D. phaseolinus.*

DIADECTES PHASEOLINUS Cope. sp. nov.

This species is represented in my collection by the maxillary bones of three animals, and a portion of the mandible with most of the tooth line of a fourth. These fragments are of about the size of the *D. sideropelicus* and *Empedocles molaris.*

The molars possess a low cusp which is nearly in the middle of the tooth. Of the lower and external cusps, the internal is the wider and more rounded ; when unworn it is as elevated as the external, but it is soon reduced by attrition. The external part of the tooth is somewhat narrowed, and there is no horizontal surface on either side of the median cusp, as in *Empedocles molaris.* The last maxillary tooth is rather small ; preceding it are eight wide transverse ones, and then two less extended transversely before reaching the broken end of my best specimen. The anterior of these is elongate, and may be caniniform, but its apex is lost. External layer smooth ; some wrinkles round the base of the median cusp.

The broken base of the molar bone is subround and small, and shows that that element is slender below the orbit.

The portion of mandible preserved is quite deep, and is incurved at the symphysis. But few of its teeth are preserved, and it is not possible to say how long the anterior ones with subround bases may have been. The molar whose crown is preserved does not differ materially from those of the maxillary series. The alveolar line does not retreat inwards from the external border as in *Empedocles latibuccatus,* resembling in this respect the *D. sideropelicus.* The external surface of the lower jaw is roughened by shallower and deeper small or minute pits closely placed.

Measurements.		M.
Length of series of eleven maxillary teeth		.075
Length of series of seven widest molars		.048
Diameter widest molar	anteroposterior	.006
	transverse	.016
Depth of mandible externally		.050
Width of mandible at middle		.026

It is possible that it may yet be necessary to refer this species to *Empedocles.*

EMPEDOCLES Cope.

Proceedings Amer. Philos. Soc., 1878, p. 516. American Naturalist, April 22, 1878 ; April, 1880.

I am acquainted with two species of this genus, *E molaris** and *E. lati-*

* *Diadectes molaris,* Amer. Naturalist, 1878, p. 565.

buccatus.* The latter is represented by portions of two mandibles in my collection; the former by two or three skulls, with part of the mandible accompanying one of them. The difference in the forms of the mandibles is well marked. In *E. molaris* the dental series is parallel to the external border of the jaw; in *E. latibuccatus* the tooth line is deflected inwards from the border, leaving a wide space.

EMPEDOCLES MOLARIS Cope.

Diadectes molaris Cope. American Naturalist, 1878, p. 565.

The molar teeth are wider in this species than in any species of the family yet known. The internal and external extremities of the crown are about equally wide and equally elevated, and there is a low median cusp. A portion of the grinding surface both internal and external to the cusp is horizontal; the surface of this portion is wrinkled. The last molar is smaller than the others. The inner border of the maxillary bones forms a curved ridge on each side of the palate, which is separated by a groove from the vomer. The latter forms a median keel at the anterior portion of the palate, where it supports two rows of small conical teeth. The palatines have their prominent internal edges juxtaposed as far as the transverse line of the last molars. There they diverge a little, and extend as two nearly parallel keels to a prominent angle on each side, opposite the middle of the zygomatic foramen. There the inner borders cease to project, and are directed obliquely outwards to the inner extremities of the quadrate bones. The external borders of the pterygoids are more elevated than the internal. The median keel of the basisphenoid arises between the internal angles of the pterygoids above mentioned, and ceases before reaching the inferior border of the occipital condyle. The external border of the exoccipital is sigmoidally flexed.

It has occurred to me that the peculiar condition of the occiput described under the head of the family *Diadectidæ*, may be due to the loss of the basioccipital bone. It would be a remarkable coincidence if this accident should have befallen the only three crania which have come into my possession.

The anterior border of the orbit is above the anterior part of the fourth molar, counting from behind. The distinct incisive foramina are longitudinal and rather large. The anterior border is opposite to the fourth tooth counting from the first incisor. The nostrils look out laterally and a little forward; the united spines of the premaxillaries form a stout septum. The incisors are not more than three or four on each side (I cannot find the premaxillo-maxillary suture), and they form a regularly convex series. With the maxillaries, the entire dentition of one side forms a gentle sigmoid curve. The median incisors are the largest; the sizes regularly diminish until the smallest are reached on the anterior part of the maxillary bone. Posterior to this point they enlarge again. Their apices are not preserved.

* *Diadectes latibuccatus*, Proceed. Amer. Philos. Soc., 1878, p. 505.

The superior surface of the skull is only partly preserved in one specimen. This renders it probable that there is a crotaphite foramen as in the crocodiles, etc. The surfaces of the external cranial elements are finely pitted, or rather punctured.

Measurements.	M.
Total length of skull	.180
Width of skull at quadrates	.145
" " " origin of zygoma	.115
" " " incisive foramen	.056
Length of dental series to posterior extremity of incisive foramen, on curve	.090
Diameters of third molar from behind { anteroposterior	.010
Diameters of third molar from behind { transverse	.021
Depth of mandible at fifth molar from behind	.048

Maxillary series of seven, and parts of the mandibular series of four, individuals, are in my collection.

HELODECTES Cope. Genus novum.

Maxillary bones of two species, which I refer to this genus, were found associated with many bones of appropriate size, among which are vertebræ of the type of *Empedocles.* The characters observable are generally similar to those of the *Diadectidæ,* where I accordingly place the genus. Its principal characters, the presence of two rows of teeth in the jaws, has already been pointed out. I may add that there is apparently a large tooth in the position of anterior incisor, in the typical species.

The species differ in the arrangement of their teeth, as follows :

Molar teeth of the two rows subequal in size, and equally numerous *H. paridens.*

Molar teeth of one row wider, and more numerous than those of the other............ *H. isaaci.*

HELODECTES PARIDENS Cope. Sp. nov.

The smallest species of the family, is of about half the linear dimensions of the *Empedocles molaris.* It is represented by a left maxillary and probably premaxillary bone, which are so far covered with the adhesive, hardened ferruginous mud of the formation, as not to expose a clean surface. The apices of all the teeth are broken off, so that the bases alone remain to indicate their number, form and positions.

Of the molar teeth proper I count six in the inner, and eight in the external row. The two series are close together, and are gently convex inwards. The bases of the teeth are wide ovals, transversely placed. In front of the eighth tooth of the external row (from behind), are two teeth without apparent mates of the internal row (possibly the latter lost). Then follows a tooth of each row, and in front of these another pair, the external being the larger. Anterior to these, the jaw is so split as to remove any teeth of the inner row, if there are any, and one large tooth of the external series stands at the extremity of the fragment. This latter exceeds the

other teeth in the length and diameter of its basal portion. From its position it is probably an incisor.

The anterior border of the orbit falls above the third tooth of the external row (counting from behind). The inner border of the maxillary bone is elevated into the ridge convex inwards, as in the other species of this family. The malar base of the zygomatic arch is a moderately stout vertical oval.

Measurements.	M.
Length of dental series	.062
Length of molar 6-8 series	.029
Width of the two molar series	.009
Vertical diameter malar bone	.013

The associated bones of the skeleton may belong to this or to the next species, or even to a small *Empedocles* whose teeth occur in the same lot. In the uncertainty of reference I do not describe them.

HELODECTES ISAACI Cope. Sp. nov.

Founded on a fragment probably of a maxillary bone, lacking both extremities, and considerably obscured by ferruginous deposit.

The characters are well marked, leaving no doubt that this species is distinct from those previously known. The bases of the teeth of one of the rows are much more extended transversely than those of the other, having the form of some of those of *Empedocles*. As in that genus, they shorten anteriorly. In the fragment, I count on this row, bases of nine teeth. In the other row, I can only definitely count three, which are opposite the second, third, and fourth of the other series (counting from behind). They are wide transverse ovals, about half the long diameter of the posterior teeth of the other series.

Measurements.		M.
Length of bases of eight larger molars		.032
Diameter of large molar	anteroposterior	.004
	transverse	.008
Length of three smaller molars		.012
Long diameter of a smaller molar		.004

This species is dedicated to J. C. Isaac, the discoverer of the first species of this family.

GANOCEPHALA.

Examination of abundant material shows the correctness of my anticipation (American Naturalist, 1878, 633), that the vertebræ of the large batrachian *Eryops*, would turn out to have the structure found in *Rhachitomus*. This genus then must be referred to the same sub-order as *Trimerorhachis*, and probably *Actinodon* Gaudry, which will be characterized by the segmented vertebral centra. If European authors are correct in stating that the vertebræ of the *Labyrinthodontia* have undivided centra, the sub-order above mentioned must probably retain the name of *Ganocephala*, with additional characters.

The identification of the scapular arch in *Eryops*, and of the pelvic arch

in *Eryops* and *Cricotus*, gives the following result: The glenoid cavity is an excavation in two coössified elements, of which the inferior and posterior is probably coracoid. The latter is then much smaller than in *Reptilia* and *Batrachia anura*, but resembles that of the salamanders. The scapular arch proper resembles that of the *Urodela*. The pelvis is intermediate between that of the anurous and urodelous *Batrachia*. There is no obturator foramen, and the common symphysis is deep. The humerus closely resembles that of the *Pelycosauria*, differing chiefly in the non-enclosure of the supracondylar foramen; and as in that sub-order, some genera possess condyles and some do not.

Prof. Owen proposed the order *Ganocephala* chiefly for *Archegosaurus*, but he included in it also the genera *Denderpeton* and *Pelion* (Paleontology, p. 182–3). This division has not been generally adopted, the genera mentioned being usually placed in the *Labyrinthodontia*. Of the eleven characters given by Prof. Owen in evidence of the existence of this order, one only does not belong also to the *Labyrinthodontia*; this is the absence of occipital condyles. On this account I thought that the group should be retained, but not as an order. Besides this group and the *Labyrinthodontia*, there were the types called *Microsauria* by Dawson, some of which have simple enamel, all agreeing in general characters, and differing from other Batrachia. I therefore combined the three groups into one order, the *Stegocephali*. (Proceedings, Academy, Philada., 1868, p. 209.) This order was most distinctly characterized in the Report of the Geological Survey of Ohio, Paleontology, ii, p. 354, 1875.

Von Meyer has given us enough of the characters of *Archegosaurus* to enable me to refer the forms of the Texan Permian to the same order. Prof. Owen, in his discussion of the affinities of that genus (l. c., p. 170), remarks, that the vertebræ and numerous very short ribs, with the "indications of stunted swimming limbs, impressed me with the conviction of the near alliance of the *Archegosaurus* with the *Proteus* and other perennibranchiate reptiles." As it is now well known that perennibranchiate batrachians belong to three different orders of the class (*Trachystomata*, *Proteida* and *Urodela*), the above expressions lose point, and especially as the characters mentioned as indicative of affinity are of the most subordinate importance, or as in the structure of the vertebræ, are totally distinct from what is found in those orders. When we read later (p. 173), that the fact that the superior "ossifications of the skull have started from centres more numerous than those of the true vertebral system, gives the character of the present extinct order of *Batrachia*;" we find that Prof. Owen has quite failed to perceive either the definitions or affinities of his new order. He commits an error in describing a distinct pubic bone; an element which Von Meyer states (Paleontographica, vi, 179, 1858) that he had not discovered. Von Meyer describes the coössified inferior elements of the pelvis as ischia. My numerous Texan specimens show that each of these bones includes both pubis and ischium.

In now defining the *Ganocephala* anew, I confine myself to characters

which I know to be common to the known genera. Some of them possess two occipital condyles. For the purpose of avoiding the multiplication of synonymes, I employ Prof. Owen's name.

Vertebræ consisting of centra and intercentra, the former not extending to the base of the vertebra, the latter not rising to the neural canal. The centrum consisting of two parts distinct from the superior neural arch; viz., a lateral piece (pleurocentrum), on each side. Atlas consisting of separate segments, the superior of which are not united above the neural canal, and the inferior (intercentrum) divided on the middle line, into two segments.

Genera. *A.* Basioccipital bone without condyles: *Trimerorhachis* Cope; *Archegosaurus* Meyer. *A. A.* Basioccipital condyles two: *Actinodon* Guadry; *Rachithomus* Cope; *Eryops* Cope.

All the above genera have well-developed neural spines except *Trimerorhachis.*

ERYOPS Cope.

Paleontological Bulletin No. 26, p. 188. Nov. 21st, 1877. Proceedings Amer. Philos. Society, 1877 (1878), p. 188.

In the essay above cited, the cranial characters of this genus were pointed out with some of those of the vertebræ. It remains to describe the other parts of the skeleton. Notices of some of these have already appeared in the American Naturalist for September, 1878 and May, 1880.

The largest element of the vertebra is the intercentrum. This, which occupies the entire inferior surface of the vertebra, is a segment, representing the sixth part of a sphere, with a slight central vacuity. The element representative of the centrum is wedged in between the superior external angles of adjacent intercentra, as in *Trimerorhachis.* These, as well as the intercentra, differ from those of that genus in their greater degree of ossification, which is so far complete as to greatly contract the *canalis chordæ dorsalis.* The central elements of opposite sides do not unite on the middle line below, although in contact. The neurapophysis is produced downwards and outwards, terminating in the simple diapophysis, with rib articulation. The inferior articular faces of the arch are two on each side, one for the central element in front, and the other for the one behind it. The whole is surmounted by a continuous neural spine, which is expanded at the summit, in the known species. The vertebræ do not differ much in different parts of the column. The cervicals are not distinguished in any way from the dorsals, but their anterior intercentra have more extensive costal surfaces, which give the inferior posterior border lateral angles. The diapophyses of the second and third cervicals are of reduced size. The neural spine of the axis is a little less elevated, and is longer anteroposteriorly than that of the third and succeeding cervicals. I do not possess an entire atlas free from matrix. Attached to the axis of this specimen are two elements which connected it with the skull, as they are separated from it only by closely fitting fractures. The elements are lateral, and each presents a semi-spherical articular face in front, and a long process with acute apex at right angles to it, posteriorly. These processes lie, one on each

side of the neural spine of the axis, above the position which would be occupied by its prezygapophysis ; they represent the distinct halves of the arch of the atlas. At the superior base of each process near the edge of the articulation is a button-like tubercle, which represents a prezygapophysis ; the inferior articular faces correspond with those of the occipital condyles in form but not in position, which is inverted. The inferior elements of the atlas are lost.

The intercentra are rather longer and more elevated in the sacral region. One only can be properly said to belong to the sacrum, and this is closely united with the one that follows it by a rough surface of contact. In old animals it may become coössified. What the relations to the intercentrum immediately preceding may be I am unable to state, owing to the condition of the specimen. A pair of caudal vertebræ are peculiar. Their intercentra are in contact throughout, excluding the pleurocentra. The latter rest above the intercentra, and between the inferior parts of adjacent neural arches. Each intercentrum supports a coössified chevron bone, and these, in the two vertebræ in question, become coössified with each other, forming a robust rod directed backwards, whose double base is perforated by the hæmal canal. This peculiar structure probably belongs near the extremity of the caudal series, as the anterior caudals observed in other specimens, are much like the dorsals.

The costal articulations are everywhere undivided, and have an obliquely vertical extension. The articular surface extends to the intercentrum in the *E. megacephalus*, forming a short superficial depression which enters from the supero-posterior border. The costal surfaces of the diapophyses become more robust anteriorly, and are more narrowed, especially at the middle and inferior portions, posteriorly. The diapophysis of the sacral vertebra is very robust, and presents a large tubercular face downwards, and a little backwards. The external side of the intercentrum about its superior angle is also covered by a large capitular facet, and the two facets support a sacral rib. This element is much more robust anteriorly than the true ribs, and its capitular and tubercular facets are distinct from each other, although they are separated by but a slight interruption. The body of the rib is plate-like, and is directed downwards and backwards, its union with the ilium being squamosal. The costal elements posterier to the sacrum diminish rapidly in size. From the size of the vertebræ in *E. megacephalus*, the tail is probably of medium length only.

The coracoid is but little incurved ; its internal border is convex, and is roughened as though for cartilaginous attachment. Its superior portion forms a convex continuum with the scapula. The direct line or external face of the scapula extends in a nearly plane surface to the glenoid cavity, embracing a perforating foramen above the latter, precisely as in the *Pelycosauria*. Its surface is continuous anteriorly with a wide expansion forwards, whose fine inner border is continuous with that of the coracoid. This plate doubtless includes a third element, but its borders are not preserved, on account of the obliteration of the sutures. It is probably epicoracoid, as in the *Pelycosauria*. In its form it is less produced than in the known scapular arches of the latter.

The coössified pelvic elements resemble, in their compression below, the corresponding parts in the *Anura*. The ilia are, however, shorter and worn as in the *Urodela*. They are flat, and stand at right angles to the line of the ischiopubic symphysis. There is an open concavity of their inferior posterior free border, and a facet-bearing elevation on the inferior border, or that entering into the formation of the acetabulum. The latter is large and half as long again as deep. The anterior and posterior borders of the pelvis descend regularly to the inferior edge, forming with it a triangle. The ischiadic or posterior border is but little thickened ; the anterior, or pubic is flat in front and presents a reverted edge outwards. This expands prominently where it is joined by a ridge which bounds the acetabulum below ; it there contracts to an inferior apex. Beneath the anterior point of the acetabulum it is pierced by the usual foramen, which issues on the inner edge of the anterior face, just above the symphysis.

The humeral bones of this genus I probably possess ; but I have several forms between which I am not able to decide. They are in general like those of the *Pelycosauria*, but differ from them in not having an enclosed supracondylar arterial foramen, but only the buttresses of its enclosing arch. Two such forms I have already described,* and a third has been obtained from the French Permian by Professor Gaudry. One quite similar to the latter I have since obtained from Texas. Not having been able at first to determine the proper reference of these humeri, I suggested to Prof. Gaudry that his humerus belongs to one of the *Pelycosauria*, and he accordingly described it as *Euchirosaurus rochei*.† I now think that there is greater reason for believing that it belongs to a species of the same group as *Eryops* and *Actinodon*.

In all these humeri the extremities are expanded in different planes, and the shaft contracted. The articular surface of the proximal extremity is band-like and passes obliquely from one side to the other as in the *Pelycosauria*. The condyles are large, consisting of a globular portion and a depressed trochlea without ridges at one side of it.

The femora are very different from the humeri, but in much the same way as in the corresponding bones of existing *Batrachia*. There are no condyles at either extremity, but outlines of such, enclosing roughened surfaces. These look as though the bases of attachment of cartilaginous caps or epiphyses. The proximal extremity is convex, and is extended in one direction. One border, the anterior, is regularly gently convex ; the opposite arc is strongly convex near one end only. The articular face is in two planes, one larger than the other. The trochanteric fossa is at first shallow, and occupies the entire width of the bone, it narrows with the shaft downwards and the borders rise, one more than the other. The two join in a strong protuberance, which looks directly backwards, and may be called for the present the third trochanter. The shaft is keeled below and in continuation of the trochanter, to where it expands for the distal articu-

* Paleontol. Bulletin, 29, 1878, p. 529.

† Bulletin Soc. Geol. France, Dec , 1878.

lar extremity. The latter looks partly downwards, and is divided by a deep groove above into two parts representing the usual condyles. One of these is comparatively depressed, while the other has a massive superior crest, which makes its long axis vertical instead of horizontal, as is that of the other condyle.

There is considerable resemblance between this femur and that of *Dimetrodon gigas*, and in a less degree to that of *Clepsydrops natalis*, but both the latter have well developed condylar surfaces. They are also larger in proportion to the size of the rest of the skeleton, in the *Pelycosaurians* mentioned.

Further characteristics of this genus and of the species it embraces will be given at a future time.

TRIMERORHACHIS Cope.

American Naturalist, 1878, p. 328 (April 22). Proceedings American Philos. Society, 1878, p. 524.

This genus, as has been pointed out, differs from *Eryops* in the superficial character of its vertebral ossifications, and in the absence of ossified neural spines.

A well-preserved cranium, and portions of several others referrible to this genus, furnish characters which have been hitherto inaccessible. They probably belong to the *T. insignis*, but this is not certain.

Generic Characters, etc.—The type of skull is that of the order of *Stegocephali* generally. The superior walls are thin, and are sculptured on the superior surface. The mucous grooves are distinct, but do not form a well-defined lyra. There is a groove which is parallel to the anterior borders of the orbit for a short distance, and which then turns forwards and then inwards. The dermal ossification is distinguished from that of the maxillary bone by a squamosal suture. A mucous groove descends to it obliquely forward from the superior quadrate region, and sends a branch at right angles to its anterior extremity to a point posterior to the orbit. Of superficial ossifications, the boundaries are difficult to determine, owing to the obscurity of the sutures. Enough can be seen to demonstrate the presence of supramaxillary, epiotic, and supraoccipital dermal bones. The nostrils are large and well-separated, and look upwards.

The teeth are acute, and of subequal size; their superficial layer is deeply inflected at the base.

The parasphenoid bone is wide posteriorly, but contracts abruptly, and extends forwards on the middle line. Owing to crushing of a part of the surface, I am unable to ascertain its anterior, or vomerine suture. The basifacial axis bone is quite narrow, and is edentulous. It is connected with the superior cranial walls by a vertical osseous plate on each side, which may represent alisphenoid, orbitosphenoid and ethmoid. The palatopterygoid arch is a longitudinally extended sigmoid, enclosing with the axial elements, an enormous choanoörbital foramen. It extends from the middle line below a short distance posterior to the position of the nostrils

outwards, and follows closely the maxillary bone well posteriorly. It then turns inwards, extending to the parasphenoid bone, with the wide portion of which it has an extensive contact. It then turns outwards as pterygoid bone, and rapidly narrowing, joins the inner distal extremity of the quadrate. It thus encloses a foramen with the quadratojugal bone, which is much smaller than the choanoörbital foramen. The posterior part of the inferior surface of the bones of this arch, not including the slender pterygoid portion, is roughened with hard nodules resembling teeth in material, and serving the purpose of such organs.

Two rod-like bones extend outwards and backwards from the posterior part of the parasphenoid and the basioccipital, which belong to the inferior arches. The anterior is the larger, and is bent backwards at an obtuse angle ; its proximal extremity is a truncate oval. This bone occupies the position of the stapes. The second is extensively in contact with the basioccipital by its proximal extremity. It is curved backwards at its distal third. The occipital condyle is represented by a fish-like cotylus, which has a deep notch at its superior border.

The mandible has a short angular process, vertical by lateral compression. The symphysis is very short and the Meckelian cavity large, and completely enclosed.

The anterior cervical vertebræ consist of the same elements as the dorsals. The intercentra of the second and third vertebræ support capitular costal articulations, somewhat elevated above the surrounding level. The pleurocentra do not support the ribs, but the neural arches terminate below in diapophyses. There is a pleurocentrum in front of the second intercentrum, and above and in front of it a neurapophysis, which has no distinct diapophysis. Its superior portion is a subacute process which is not in contact with that of the other side, but is separated from it by a vertical osseous plate, which is probably the neural spine of the second vertebra or axis. This is similar to the structure already observed in *Eryops*, and the parts being in place, should explain those of that genus. The portion of the atlas which represents the intercentrum is divided into two lateral portions, each of which has the form of an entire intercentrum, i.e., crescentic. The intercentrum of a cervical of a large species of this group, is wider than that of the other vertebræ, and presents two articular facets anteriorly.

Specific Characters.—The skull is flat and rather wide, the length exceeding a little the transverse posterior diameter. The posterior borders of the orbits mark a point half way between the extremity of the muzzle, and the posterior supraoccipital border. The orbits themselves are of medium size, and are separated by a space about equal to their transverse diameter. Their form is a wide oval, with the long axis obliquely anteroposterior. The diameter of the external nostril is nearly half that of the orbit, and the form is similar to that of the latter. The interorbital and ethmoid regions are concave ; the prefrontal regions are convex. The supraoccipital border is strongly concave ; and the notch separating the epiotic angle from the quadrate angle is as deep as the supraoccipital. The

surface of the cranium is thrown into wrinkles which form no regular pattern, and which inosculate to a moderate extent, most so on the preorbital region. The anterior parts of the maxilliary and mandibular bones are marked with small pit-like impressions.

Measurements.	M.
Total length to quadrate angles measured on median line	.170
Length to supraoccipital border	.138
Total width posteriorly	.155
Width at orbits	.095
" between orbits	.021
" at nares	.062
" between nares	.030
Long diameter of orbits	.026
Transverse diameter of occipital cotylus	.012

This cranium is much shorter and wider than that of *Archegosaurus decheni*, and has the orbits more anteriorly placed.

CROSSOPTERYGIA.

ECTOSTEORHACHIS Cope, gen. nov.

Tribe *Crossopterygia;* family *Rhombodipteridæ* Traquair; sub-family *Saurodipterini* Huxley. Pectoral and ventral fins rather acutely lobate, with few or no radii on their external borders. Dorsal and anal fins unknown. Scales imbricate, rhombic, smooth. Ganoine wanting from top of head in specimens examined, but present on sides and inferior surfaces. Coronal suture distinct. End of the muzzle covered with separate scales. Distinct sub- and postorbital bones. Gular bones, an anterior azygus and two laterals on each side, the posterior the shorter. Teeth acutely conic, rather small; a few large ones at the anterior part of each jaw. Vertebral centra represented by osseous rings which enclosed a notochord.

This new genus is apparently nearly related to *Megalichthys*, and in a less degree to *Osteolepis* and *Diplopterax*. Pander, Miller and others represent the ventral fins of the two genera last named as not lobate, but sessile, a state of things entirely different from what is observed in *Ectosteorhachis*. The sub-division of the dermal bones of the muzzle is also rather characteristic of *Megalichthys*. From the latter genus it differs in the form of the vertebral centra. Both Agassiz and Huxley describe those of *Megalichthys* as completely ossified, and as biconcave. In *Ectosteorhachis* they are represented by annular ossifications resembling somewhat those of the stegocephalous genus *Cricotus*, but with a larger *foramen chordæ dorsalis*.

The elongate-lobate axis of the fins of this genus render it probable that those of *Megalichthys* present the same character.

Ectosteorhachis nitidus Cope, sp. nov.

This fish is represented by several specimens, the best preserved of which includes the head and body inclusive of the ventral fins. These form an chthyolite nearly denuded of matrix, the inferior side being best preserved.

No indications of dorsal fin are to be found in the specimen, and those which exist must originate behind a point above the base of the ventral fins. The pectoral fins originate further behind the head than is usual. The ventrals are well posterior, and close together.

The skull is transversely fractured at the coronal suture, as I suppose it to be, which divides the front, just anterior to the point of attachment of the hyomandibular bone. At the antero-external angles of the parietals, are distinct post-frontal bones of a sub-triangular form, which send a process posteriorly from their external angle. The hyomandibular presents a narrow convex external edge, and is directed backwards and downwards. It leaves a wide space posterior to the postorbital bones. Of the latter there are two, the inferior connected with the front of the orbit by a single wide, suborbital bone. The orbits are as much lateral as vertical, and are in front of a transverse line dividing the skull equally. The muzzle is broadly rounded, and is covered with rounded plates of ganoine. Several of these have median perforations. The opercular apparatus is obscured by matrix in the specimens; a small bone lies on the inferior part of the suspensorium on both sides, and may be the preoperculum. The top of the head behind the muzzle is entirely without ganoine layer in two specimens; its surface is smooth, or weakly finely ridged. On the other hand, the premaxillary, maxillary, mandibular and gular bones are invested with perfectly smooth ganoine.

The pectoral fins are quite wide, and their rays diverge exclusively from the inner border, and are very fine. The axial portion is thick and acuminate, and has no fulcra on the external edge, but is covered with quadrate and rhomboidal scales, of very much smaller size than those of the body. The axial portion of the ventral fins is not quite so large as that of the pectoral.

The scales of the body are quite large and overlap each other by both the free edges. Though their form is rhombic, the apex is rounded. The surface is ganoid, and entirely smooth. There are five rows between the internal bases of the ventral fins, and twelve between the external bases of the pectorals. The gulars of the posterior pair are about as long as those of the anterior. There are anteriorly one and posteriorly two rows of plates between the anterior gulars and the mandible.

This fish was probably three feet in length.

Measurements.	M.
Length of head to base of first distinct lateral body scale (posterior border of skull damaged)........................	.161
Length to base of pectoral fin........................	.180
" (axial) to canthus oris........................	.077
" of skull to coronal suture........................	.067
" " " anterior border of orbit..............	.021
Width " at " " "	.065
" of front between " " "	.036
" " at coronal suture........................	.029

Measurements.		M.
Width of skull at canthus oris		.145
Length of inferior canine tooth		.006
Width between bases of pectorals		.092
Length of basal axis of pectoral		.060
" " " " ventral		.035
Width between bases of ventrals		.033
Diameters of exposed parts of an abdominal scale	fore and aft	.012
	longitudinal	.015

The *Megalichthys hibberti* Ag., which this species resembles in some degree, is represented by authors as having the scales minutely granulated on the surface. The ganoine layer also covers the superior surface of the skull, a peculiarity which is not present in the *Ectosteorhachis nitidus.*

Explanation of Figures.

Figure 1.—*Skull of Eryops megacephalus* from above, one fifth natural size.

Fig. 2.—The same skull, profile.

Fig. 3.—The same from below.

Fig. 4.—Mandibular ramus from above, one-fourth natural size.

Fig. 5.—A large part of the vertebral column of a second specimen from the left side, one-fourth natural size.

Fig. 5.—The same from below.

Fig. 7.—Anterior view of atlas and axis, natural size.

Fig. 8.—Posterior view of a dorsal vertebra, natural size.

Fig. 9.—Inferior part of scapula with coracoid, of same animal, external side.

Fig. 10.—Same, interno-posterior view.

Fig. 11.—Pelvis of the same individual, left side.

Fig. 12.—Same, from front.

Fig. 13.—Same, from behind.

Fig. 14.—Same, from below.

Fig. 15.—Femur of same individual, from above.

Fig. 16.—Same, from below and behind.

Fig. 17.—Proximal end.

Fig. 19.—Distal end.

Fig. 9.—Inferior view of skull of *Empedocles molaris*, one-half natural size.

Fig. 10.—Posterior view of the same skull, half natural size.

Fig. 11.—14 bones of *Dimetrodon incisivus*, one-fourth natural size, from a single individual.

Fig. 11.—End of muzzle, left side.

Fig. 12.—Lateral view of a large part of the vertebral column.

Fig. 13.—Thirteenth vertebra, lacking the summit of the neural spine, from behind.

Fig. 14.—Fourteenth vertebra, lacking apex of neural spine, from front.

Fig. 15.—Nineteenth vertebra of same skeleton, lacking most of neural spine, from behind, two-thirds natural size.

Fig. 16.—Sacrum of same from front, two-thirds natural size.

The above figures will appear in the Proceedings of the American Philosophical Society.

Published, June 5, 1880.

PALEONTOLOGICAL BULLETIN, NO. 32.

SECOND CONTRIBUTION

TO THE

History of the Vertebrata

OF THE

PERMIAN FORMATION OF TEXAS.

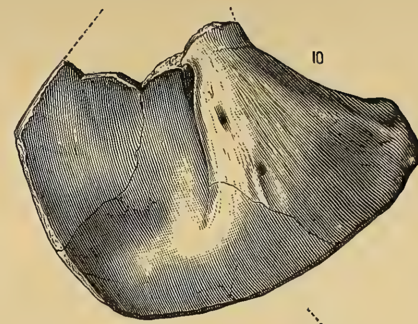
FIGURES.

BY E. D. COPE.

MAY 2, 1881.

1

10



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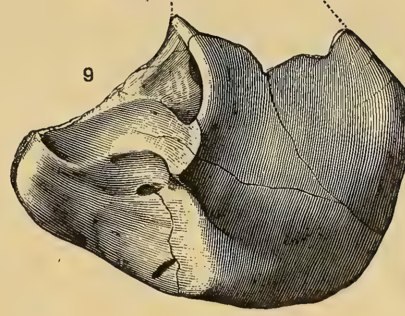
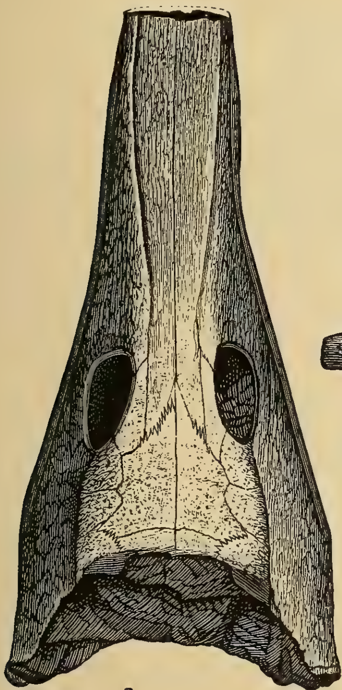


ERYOPS MEGACEPHALUS. Fig. 1, $\frac{1}{5}$ nat. size. Figs. 9–10, $\frac{4}{15}$.



a

b

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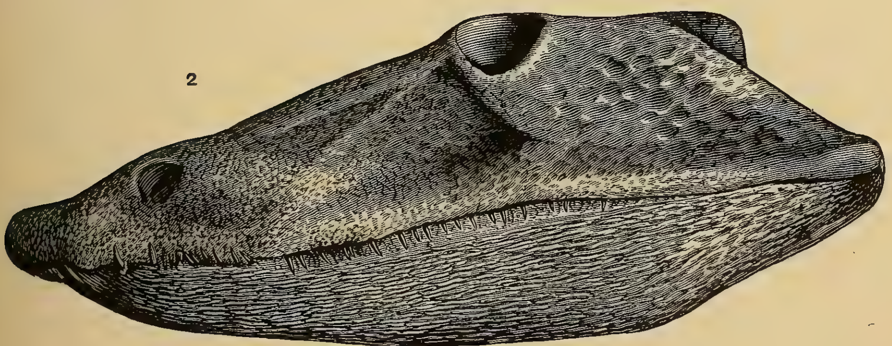
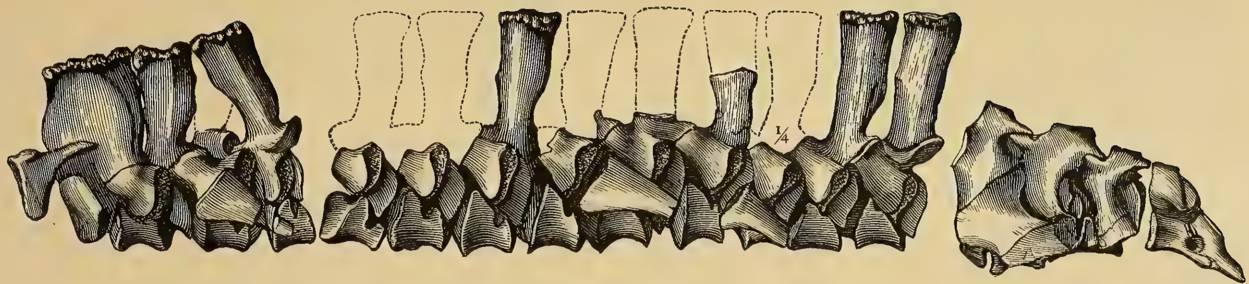


a–b CRICOTUS sp. $\frac{1}{2}$.

2 ERYOPS MEGACEPHALUS. $\frac{1}{5}$.

PLATE III.



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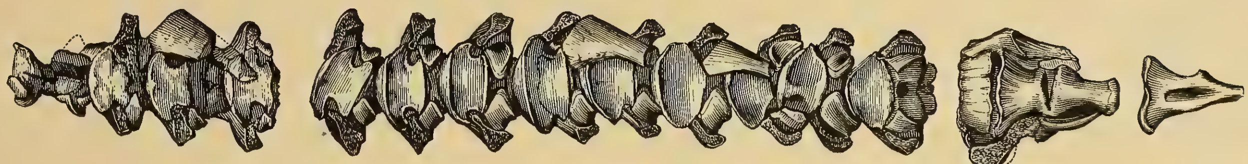

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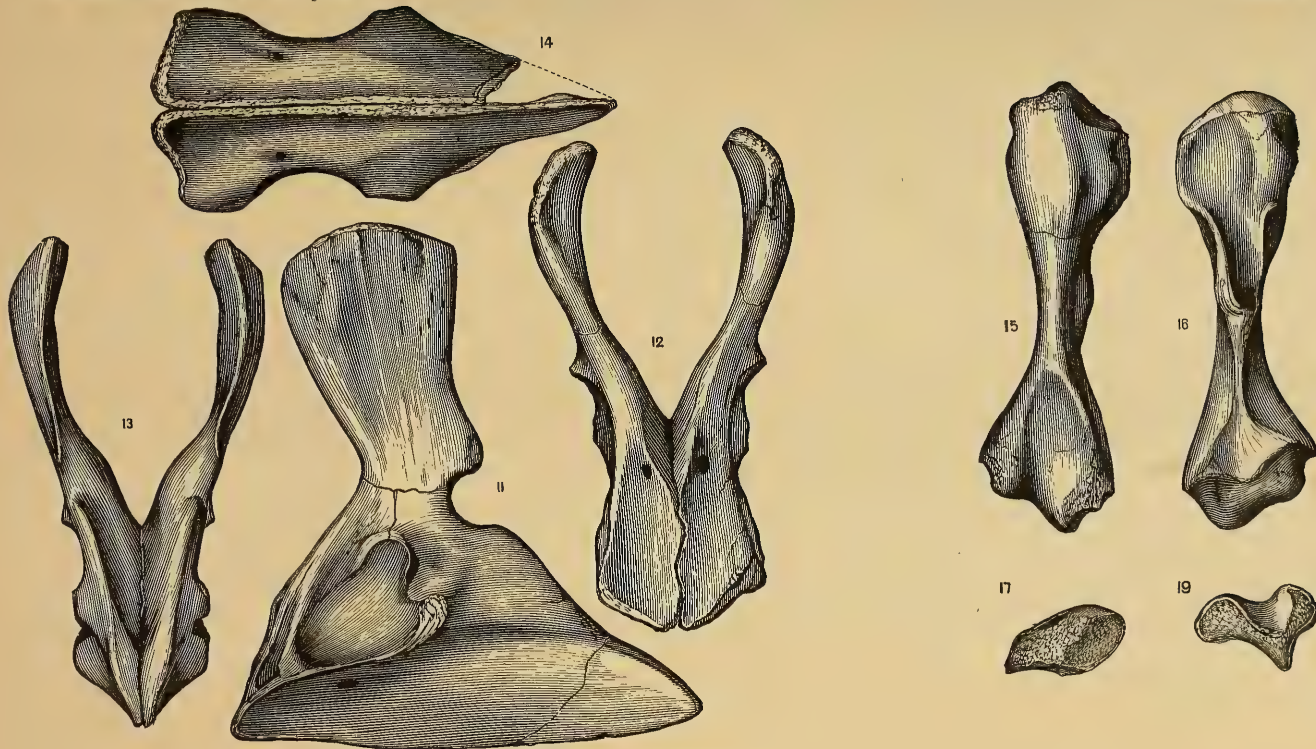
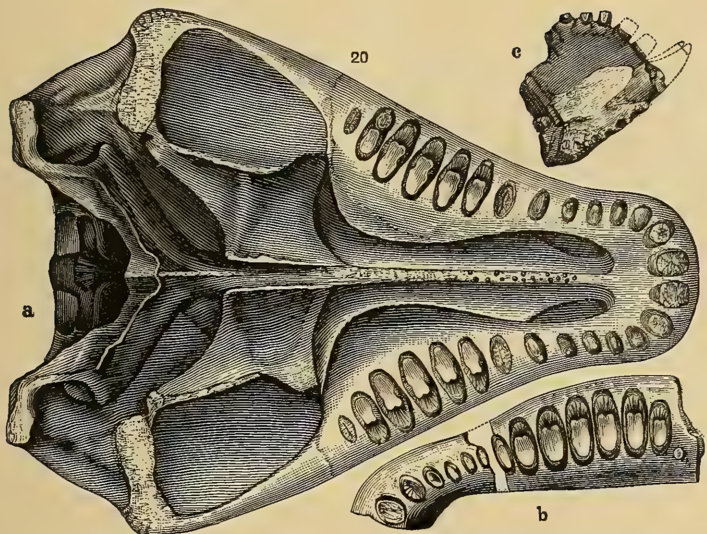
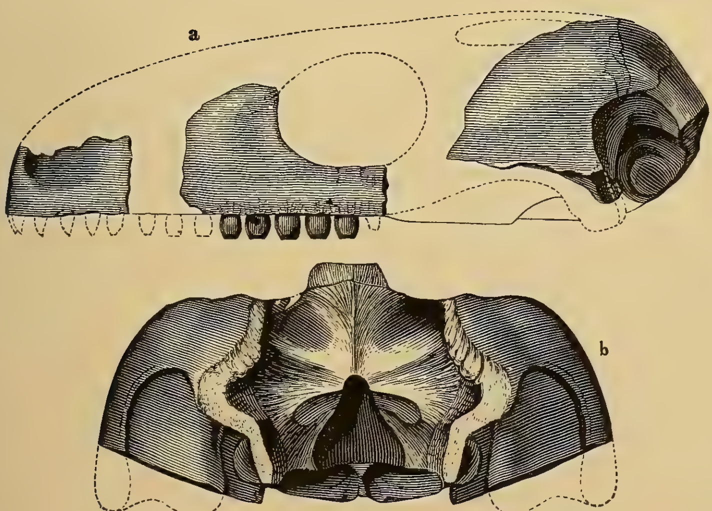
ERYOPS MEGACEPHALUS. $\frac{1}{4}$.

PLATE IV.



ERYOPS MEGACEPHALUS. $\frac{4}{15}$.





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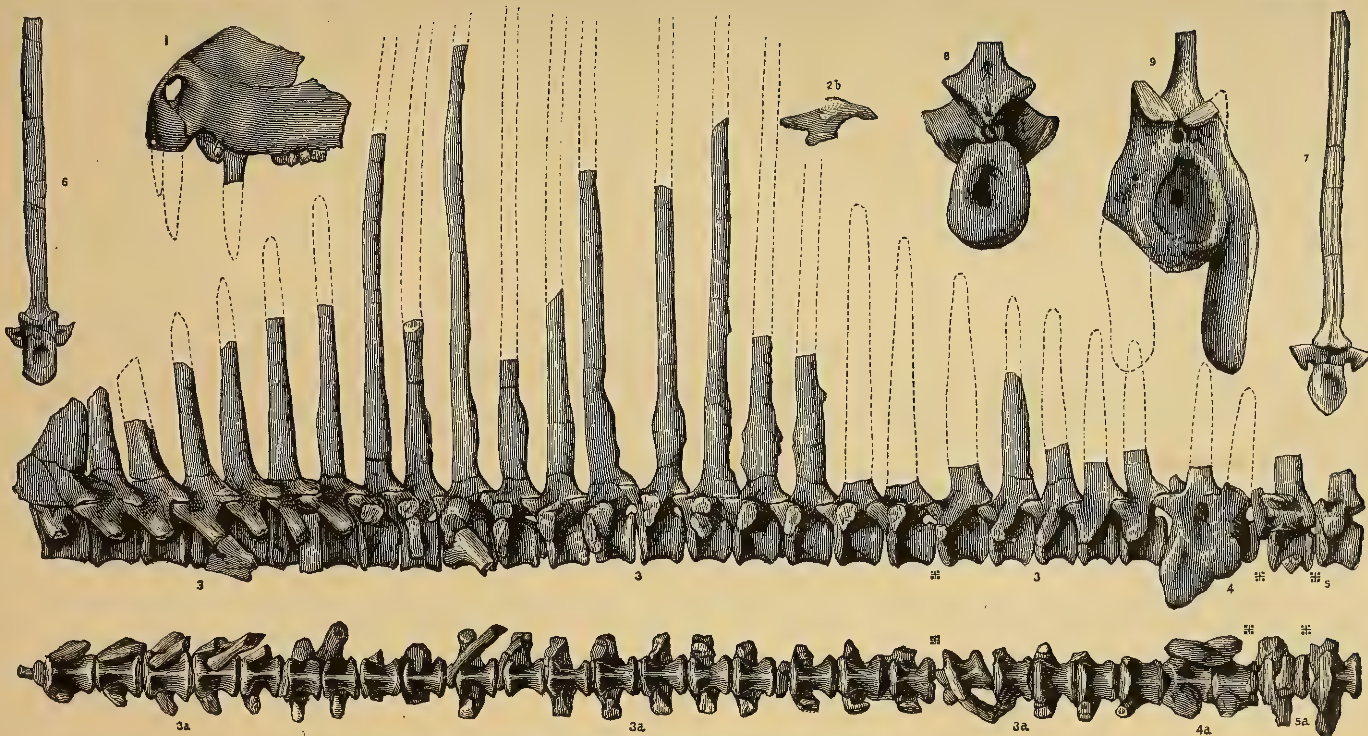
EMPEDIAS MOLARIS. $\frac{1}{2}$.

PLATE VI.



22–27 DIMETRODON INCISIVUS, $\frac{1}{4}$, except 8 and 9, $= \frac{2}{3}$.

PALÆONTOLOGICAL BULLETIN, No. 33.

ON SOME MAMMALIA
OF THE
LOWEST EOCENE BEDS OF NEW MEXICO

By E. D. COPE.

(*Extr. Am. Phil. Soc.*)

(Read before the Amer. Philosophical Society, Sept. 17, 1881.)

FOR SALE BY A. E. FOOTE,

1123 BELMONT AVENUE,

PHILADELPHIA.

On some Mammalia of the Lowest Eocene beds of New Mexico. By E. D. Cope.

(*Read before the American Philosophical Society, Sept. 17, 1881.*)

Mesonyx navajovius, sp. nov. Smaller than the two known species, and with the crowns of the molars more compressed and the blades of the heels of the inferior series more acute. Molars seven, the first one-rooted. Last molar with a cutting heel like the others, and with the penultimate, with a rudimental anterior inner cusp. All the molars with an anterior basal tubercle except the first, second and third. No basal cingula. Principal cusp elevated and compressed, as in the premolars of *Oxyæna.* Enamel minutely rugose. Mandibular rami and inferior canine teeth compressed, the angle of the latter not inflected. Length of inferior molar series M. .078 ; do. of premolar series .046 ; fourth premolar, length of base .010 ; elevation of cusp .008 ; second true molar, length .012, elevation .010 ; width of heel .005 ; depth of ramus at .020 ; diameter of base of crown of canine, vertical .009.

Periptychus carinidens, gen. et. sp. nov. Creodontium. *Char. Gen.* No distinct sectorial teeth, the first and second true inferior molars similar. They support a principal median cusp, a broad heel and a prominent anterior cingulum. The heel is more or less divided into tubercles ; the anterior cingulum is on the inner side, and represents the anterior cusp of a sectorial tooth. On the inner side of the principal cusp a cingulum rises, forming a flat internal tubercle. Last molar not smaller than the others ; premolars unknown.

This genus belongs to the *Amblyctonidæ* with *Amblyctonus* and *Palæonyctis.* It differs from both in the rudimental character of the anterior cusp, and from the former, in the presence of the internal tubercle. In *Mesonyx* the heel has a median cutting edge. *Char. Specif.* Parts of both mandibular rami and the shaft of a humerus represent this species. They indicate an animal of the size of the red fox, but much more robust. The mandibular ramus is rather shallow and thick, and the molars are not large. The heel of the penultimate supports three tubercles, of which the external is the largest. The anterior cingulum supports a small cusp, and then rises to the internal tubercle, which is compressed. The sides of all the cusps are marked with distinct, well separated, vertical ridges. Each extremity of the internal cusp is connected with the principal cusp by a ridge. The first true molar has fewer cusps. Those of the heel are scarcely distinct, and form a border which rises prominently into the flat internal tubercle, which forms a narrow longitudinal blade. The anterior cingulum has no cusp and does not rise into the inner tubercle. The principal cusp has a strong entering groove next the inner tubercle. Length of crown first molar .0115 ; width of do. .006 ; elevation of do. .006. Length of second molar .011 ; width of do. .007 ; elevation of do. .0065. Depth of ramus at do. .020. The species is a good deal smaller than the *Amblyctonus sinosus.*

TRIISODON QUIVIRENSIS, gen. et sp. nov. *Char. gen.* Derived from the lower jaw. Probably only three premolars. True molars alike, consisting of three anterior cusps and a heel. The cusps are relatively small and the heel large. Of the former the internal is much smaller than the external, and the anterior is rudimental, being merely a projection of the cingulum. The cutting edges of the large external cusp are obtuse. The heel is basin-shaped, and its posterior border is divided into tubercles, of which the external is a large cusp. The fourth premolar has no anterior inner tubercle, so that the anterior part of the crown consists of a compressed cutting cusp. The heel has two well-developed posterior cusps. The third premolar has a similar principal trenchant cusp, but a smaller heel. Canines large.

This genus differs from *Herpetotherium* and *Ictops* in the simplicity of its fourth inferior premolar, and from *Stypolophus* and *Deltatherium* in the rudimental character of the accessory anterior cusps of the true molars, as well as in the three premolars. The rudimental anterior cusp of the true molars, with the three similar true molars, separates it from *Palæonyctis,* and the presence of a conic inner cusp of the same indicates it as different from *Amblyctonus* and *Periptychus.* It is not possible to state whether *Triïsodon* must be placed in the *Amblyctonidæ* or not, on account of the absence of the superior molar teeth.

This specimen of the type species of this genus is instructive as showing the succession of premolar teeth. Both the third and fourth premolars have temporary predecessors. The predecessor of the fourth premolar differs much from it in form, and is essentially identical in all respects with the true permanent molars. The crown of the predecessor of the third premolar is wanting, the roots only remaining in the jaw.

The permanent third premolar was protruded before the permanent fourth. Which temporary tooth of *Triïsodon* is homologous with the single one of the *Marsupialia* pointed out by Professor Flower?* As the additional permanent teeth of the placental *Mammalia* must have appeared later in time than the one already found in the implacentals, they must be those later protruded; hence the fourth tooth in the jaw of *Triïsodon* must be regarded as homologous with the fourth premolar of a placental, which is the last of that series to appear. If this be true, the tooth which follows the shed tooth of the Marsupials is not the fourth premolar, as supposed by Professor Flower, but the third premolar. This view is confirmed by the fact that the milk tooth displaced by the fourth tooth in *Triïsodon* resembles in all respects the true molars, just as the permanent tooth occupying the same position does in *Didelphys* and some extinct eocene genera. This goes to show that this tooth, permanent in marsupials, is temporary in placentals, and that, in spite of its form in the former group, it is the fourth premolar, and not the first true molar, as supposed by Professor Flower. Thus the posterior milk-molar of diphyodonts is a permanent tooth in the *Marsupialia.*

* Transactions of the Royal Society, 1867, p. 631.

This observation confirms my conclusion that the *Credonta* form a group intermediate between the *Marsupialia* and *Carnivora*. I may add that in *Triisodon* the inferior border of the lower jaw is not inflected posteriorly.

Char. specif.—Size about that of the wolf. Inferior canine directed upwards, its section nearly elliptic; a faint posterior, no anterior cutting edge. Fourth premolar rather large, with an anterior basal cingulum which is angulate upwards, and is not continued on the inner side of the crown. Cusps of the heel each sending a ridge forwards, the internal lower, obtuse and descending to base of inner side of large cusp; the external larger, with an acute anterior cutting edge continuous with the cutting edge of the large cusp. True molars with an external, but no internal basal cingulum. Border of heel with one large and three smaller tubercles, the former with, the latter without, anterior cutting edge. Enamel of all the teeth nearly smooth. All the cusps are rather obtuse. *Measurements.*—Length of inferior molar series: M. .080; long diameter of base of canine .013; length of true molar series .044; length of base of Prem. IV. .016; elevation of crown of do. .014; length of base of M. II. .016; width of do. in front .011; elevation of do., .014. The measurements of the jaw are not given, as the animal is not adult, the last molar not being yet protruded.

From the lowest Eocene beds of New Mexico.

Deltatherium fundaminis, gen. et sp. nov. *Char. Gen.* Fam. *Lepticticidæ*, agreeing with *Ictops* and *Mesodectes* in possessing an internal tubercle of the third superior premolar, but differing from both in having but one external cusp of the fourth superior premolar. *Char. Specif.* Represented by the dentition of both maxillary bones minus the canines. The second premolar is convex on the inner face. The base of the third is a nearly equilateral triangle. The bases of the true molars are triangles, with the bases external. The internal angle supports an acute cusp, and has a posterior basal cingulum, which is very strong in the last three molars. The two external cusps of the first and second molars are situated well within the base, which is folded into a strong cingulum. This cingulum develops strong anterior and posterior angles. This is the largest species of the family yet discovered. Extent of series of last six molars, M. .045; of true molars .026; diameters of fourth premolar, anteroposterior .0074; transverse .0076; do. of second true molar, anteroposterior .0087; transverse .0100. This species was a fourth larger than the common opossum, and very much resembles it in dental characters.

Conorycetes comma, gen. et sp. nov. *Char. Gen.* Allied to *Mesonyx*. Inferior canines not rodent-like, with conic crowns. Molars 3—3, the first one-rooted, the second two-rooted, the third with an anterior conic cusp and a posterior grinding heel. True molars consisting of two lobes, of subcylindric section, separated by deep vertical grooves. Enamel developed on internal and external faces of crowns. *Char. Specif.* Founded on a mandibular ramus which lacks the last molar, and has the crowns of the others worn. The external faces of the molars are much more ex-

posed than the internal, and are somewhat contracted inwards. In the unworn crown there is a distinct anterior inner cusp, which is soon confounded on attrition. The heel of the last premolar has a crescentic section, the internal horn the narrower. The anterior lobe is a robust cone. The base of the second and third premolar is oblique to the axis of the ramus outwards and forwards. It is possible that there is a minute first premolar filling the short space between the second and the canine. No cingula ; enamel obscurely plicate, ramus robust. Length of molars minus the last .0465 ; length of base of first true molar .010 ; width of do. .009 ; elevation of crown do. .0055 ; length of base of fourth premolar .011 ; width of do. .008 ; elevation of crown of do. .0065. Anteroposterior diameter of base of crown of canine .010. Depth of ramus at first true molar .023 ; width of do. at do. .013. This genus differs from *Esthonyx* in the form of the fourth premolar. In the latter the anterior lobe is compressed and trenchant. The species is larger than any of that genus, and nearly equal to the *Ectoganus gliriformis.*

CATATHLÆUS RHABDODON, gen. et sp. nov. *Char. Gen.* With this genus I commence descriptions of several genera with bunodont dentition, which has some resemblance to that of some of the hogs. The one above named, with *Mioclænus,* remind one of *Tetraconodon* Falc. and Lydd., in the enlarged proportions of their premolar teeth. I compare the genera as follows, introducing a probably perissodactyle form (*Protogonia*) for comparison :

I. Third and fourth superior premolars one or two lobed externally, and with internal lobes.

a. Superior premolars with two external lobes ; inferior fourth with two median cusps.

Intermediate tubercles ; premolars not enlarged............. *Phenacodus.*

aa. Superior premolars enlarged, generally with one external cusp.

β. A posterior internal cusp of superior molars ;

Intermediate tubercles present ; last inferior premolar with inner cusp ; *Catathlæus.*

Intermediate tubercles wanting, replaced by branches of an internal V ; no cusp on inner side of last inferior premolar........ *Anisonchus.*

Intermediate tubercle present, connected with anterior inner by ridges ; inferior molars with Vs............................ *Protogonia.*

ββ. No posterier inner cusp of superior molars.

Intermediate tubercles present ; no inner lobe of last inferior premolar *Mioclænus.*

II. Superior premolars 1, 2 and 3 without inner lobe ; third with three external lobes (Pictet).

Premolars compressed...................................... *Dichobune.*

In the genus *Catathlæus* the development of the premolars is remarkable while the true molars are relatively small. The last three superior premolars have an elevated internal crescentic cingulum homologous with

the inner lobe of the fourth superior premolar of the ruminants. The general character of the true molars is that of *Phenacodus*. Parts of two or three individuals of this species have come into my possession, one of which includes nearly all of the molar dentition of both jaws. The external cusp of the superior premolars is compressed conic, and the internal cingulum extends to its *anterior* base in the second, third, and fourth. The crown of the last true molar is about as long as wide, while that of the first is wider than long. Each supports seven cusps; two subconic external, and one large median internal, which is connected by ridges with a small anterior and posterior median. Then there are a small anterior and posterior internal, making three internal. The internal crest is distinct from the principal cusp in the inferior premolars III and IV, but unites with it in the II; it supports on the IV an anterior, a median and a posterior cusp, the latter forming part of the rather narrow heel. The true molars I and II have seven tubercles, the four principal ones, and three smaller, one anterior, one posterior, and one median. On the third the posterior forms a large heel. All of the molars, but especially the premolars, have the enamel thrown into sharp vertical parallel folds, in a manner I have not seen in any other mammal. Length of six superior molars .067; length of three true molars .029; length of base of third premolar .012; width of do. .012; width of base of first true molar .010; do. of third true molar .009; length of do. .010. Length base fourth inferior premolar .012; width do. .010; length of third true molar .0115; width of do. .009. The teeth indicate an animal of the size of the peccary.

Anisonchus sectorius, gen. et sp. nov. *Char Gen.* This is derived from the superior P-m. IV and M. I and II, and from all the inferior molars of three individuals. The superior teeth are accompanied by a ramus mandibuli, which contains alveoli of all the inferior molars, and the crowns of the P-m. IV and M. II. The leading characters have been given above. The inner posterior lobe is more prominent in this genus than in any of the others, and has a V-shaped apex. It projects further inwards than the anterior inner lobe. It is represented by a mere tubercle of the cingulum in *Mioclænus*. In the lower jaw the last premolar is quite simple, consisting of a principal cusp, and a non-cutting heel. The second true molar has intermediate anterior and posterior cusps. The genus differs from *Pantolestes* in the more numerous tubercles of the molars, and in the fact that the anterior inner tubercle of the true molars is not double. It may, however, be allied to that genus.

Char. Specif. The fourth superior premolar covers a larger base than either of the true molars. The external cusp has a base extended anteroposteriorly, but the apex is conical, and there are no basal tubercles. The inner cusp has a crescentic base as in *Catathlæus*, but the apex is narrowed and compressed conic. The external tubercles of the true molars are subconic, and do not develop any external ridges. They are connected by the crescentic slightly angular crest, whose apex forms the inner ante-

rior boundary of the crown. This crest is not divided into parts homologous with the intermediate tubercles. The crowns of the M. I and II are surrounded by a basal cingulum, which in the M. I develops a tubercle at the anterior external angle. No internal or external cingulum on P-m. IV. Enamel nearly smooth.

The ramus of the mandible is rather slender anteriorly. The P-m. IV is robust, and the cusp is behind the middle of the base of the crown. The heel is short and narrow, and has a raised border, connected with the base of the main cusp. The cusps of the second true molar are elevated and conic, the anterior external the highest, the others subequal. The base of the posterior pair is a little narrower than that of the anterior pair. There is no central tubercle as in *Catathlæus rhabdodon*, and no basal cingulum on either tooth.

Measurements.		M.
Length of three superior molars		.0160
Diameters superior P-m. IV	anteroposterior	.0055
	transverse	.0070
Diameters superior M. I	anteroposterior	.0052
	transverse	.0060
Length of inferior molar series		.0610
" " " true molar series		.0160
Diameters inferior P-m. IV	anteroposterior	.0060
	transverse	.0040
Diameters inferior M. II	anteroposterior	.0050
	transverse	.0040
Depth ramus at M. II		.0090

A number of minor points will distinguish this species from those included among the *Mesodonta*, and especially those of *Pantolestes*, which it most resembles. The molar teeth are narrower behind, and the fourth premolar is larger. It is *Mioclænus sectorius*, American Naturalist, October, 1881, p. 831.

MIOCLÆNUS TURGIDUS, gen. et sp. nov. This genus differs from *Catathlæus* in the structure of the inferior premolars, which are without internal crest or cusp. The inner lobe of the superior premolars is less developed than that genus. In the present species the characters of *Mioclænus* are best seen in the subconical tubercles of the premolars, particularly that of the heel of the fourth inferior premolar. In the other three species this heel is more of a crest and is connected with the principal cusp by a low ridge. The four species may be characterized as follows :

a. Cusps of last premolars conical in both jaws.

Size medium. Last lower molar disproportionately small ; cusps low ; two anterior inner distinct ; true molars, .018 .... *M. turgidus.*

aa. Fourth superior premolar with flattened external and conic internal cusp ; inferior unknown.

Size medium; fourth upper premolor equilateral; all cusps acute; true molars .0165..*M. subtrigonus.*

aaa. Cusps of last premolars compressed in lower jaw.

Least. Second and third lower true molars subequal; cusps, especially the internal, elevated; anterior inner confluent into an edge; true molars, .013...*M. angustus.*

Largest; cusps of inferior molars obtuse; P-m. III .008, its heel short and small.......................................*M. mandibularis.*

Medium; last inferior molar larger than penultimate; true molars, .014; P-m. III .006.................................*Anisonchus sectorius.*

Of *M. turgidus* there are two specimens; and of *M. subtrigonus, M. angustus* and *M. mandibularis* one each.

In the *M. turgidus* there are no cingula on the fourth premolar. It is wider than long, and the external face is a little flattened. The tubercles are conic; the external has a small one at the anterior base, and a rudiment at the posterior base, and there is a low one on the posterior side at the middle. The second true molar is wider than the first. The tubercles are all round in section. Besides those already mentioned, there is a rudiment of a posterior inner on the first, which is represented by a cingulum on the second. The latter has basal cingula all around except on the inner side; the same are visible on the first true molar in a rudimental condition. Enamel nearly smooth.

The inferior molars are of robust proportions. Their sizes are, commencing with the largest: P-m. IV; M. II; M. I; M. III. The last molar is only half as large as the penultimate. It has two anterior and an external lateral tubercles, and a heel. On the penultimate molar, there are two anterior tubercles with a trace of anterior inner; also a broad flat heel, with a low tubercle on the external side. The constitution of the first true molar is identical. The fourth premolar has a rudimental heel consisting of a low tubercle only. The principal cusp is conic and is over the middle of the transverse diameter, and a little behind the middle of the anteroposterior diameter. No cingula. Enamel nearly smooth.

Measurements.		M.
Maxillary bone.		
Length of base of P-m. IV, M. I and M. II		.0175
Diameters base P-m. IV	anteroposterior	.0055
	transverse	.0065
Diameters base M. I	anteroposterior	.0060
	transverse	.0070
Diameters base M. II	anteroposterior	.0060
	transverse	.0095
Mandible.		
Length of bases of last four molars		.0250
Diameters P-m. IV	anteroposterior	.0070
	transverse	.0055

Measurements. M.

Diameters M. I	anteroposterior	.0060
	transverse	.0060
Diameters M. III	anteroposterior	.0055
	transverse	.0043
Depth of ramus at M. I		.0115
Thickness " " "		.0085

Mioclænus subtrigonus, sp. nov. Represented by a portion of a cranium anterior to the orbits and lacking the extremity of the muzzle, distorted by pressure. It exhibits nearly all of the molar teeth. The species differs from *M. turgidus* in the greater acuteness of all its cusps, and in the equilateral form of the fourth premolar. It is too large to belong to the *M. angustus*, which is represented by a mandible only ; and too small to be the *M. mandibularis*, whose maxillary dentition is unknown.

The inner borders of the molar teeth are shorter than the outer, especially in the last two molars. The last true molar is smaller than either of the others. The cusps are all subconical, but the internal is connected with the intermediate by ridges, which give it a triangular section. The latter form a V, homologous with that in *Anisonchus*, but not so distinct, and the intermediate tubercles are not lost in its branches as in that genus. The posterior inner lobe of that and other genera, is represented by a thickening of the cingulum. This cingulum extends entirely round the P-m. IV and M. I, and M. II ; the M. III is injured. The sides of the base of the P-m. IV are slightly concave. The enamel of all the molars is wrinkled.

Measurements. M.

Length of bases of last five molars		.0285
Diameters of base of P-m. IV	anteroposterior	.0060
	transverse	.0050
Diameters of base of M. I	anteroposterior	.0060
	transverse	.0060
Diameters base of M. II	anteroposterior	.0060
	transverse	.0075
Diameters base of M. III	anteroposterior	.0040
	transverse	.0060

Mioclænus angustus Cope, American Naturalist, 1881, October (September 22d), p. 831. The least species of the genus, with the teeth about the size of *Hyopsodus paulus* Leidy, but with more robust jaw. The molar teeth diminish in size regularly posteriorly from the P-m. IV. They all have three subequal posterior cusps which are less elevated than the anterior ones. The median is enlarged into a heel on the last tooth. The anterior are opposite, and the external is larger than the internal. There is no anterior internal. The external wears into an anteroposterior narrow grinding surface, which looks like a combination with an anterior median. The latter is, however, not separate on the least worn molars. The

anterior outer cusp increases in size anteriorly, and is the large cusp of the P-m. IV. It sends a branch backwards on the inner side of the crown which forms the edge of the narrow concave heel. There are no cingula except a short one on the anterior corners of the base of the crown of the P-m. IV. Enamel obscurely wrinkled.

Measurements.		M.
Length of posterior four molars		.0180
Diameters of P-m. IV	anteroposterior	.0050
	transverse	.0035
Diameters of M. I	anteroposterior	.0050
	transverse	.0035
Diameters of M. II	anteroposterior	.0040
	transverse	.0032
Diameters of M. III	anteroposterior	.0045
	transverse	.0030
Depth ramus at M. I		.0110
Thickness " " "		.0060

PHENACODUS PUERCENSIS, sp. nov. Three individuals. Last superior molar smallest; first and second true molars with six tubercles, two external, two median and two internal. A strong basal cingulum except on inner side. Inferior true molars besides the usual five tubercles, furnished with an anterior ledge with a tubercle at its interior extremity. A weak external basal cingulum. A little larger than the *P. vortmani.* Length of superior true molars M. .021; length of base of crown of M. III .006; do. of M. I .008; width of do. .008; length of base of crown of inferior M. III .0085; width of do. in front .006; depth of ramus at M. I .019.

PHENACODUS ZUNIENSIS, sp. nov. The least species of the genus, represented by the mandibles of two individuals. The first and second true molars are narrowed in front, and there is no distinct anterior ledge, only a minute anterior inner tubercle. The external cingulum is more distinct and the enamel is wrinkled. The fourth premolar has a short base and the inner cusp is much smaller than the principal one; it has a wide heel and an anterior basal tubercle. Length of true molars, M. .018; of last true molar .006; of base of first true molar .006; width of do. .004; depth of ramus at do. .011.

PROTOGONIA SUBQUADRATA, gen. et sp. nov. Fourth superior premolar with one external and one internal lobe. True molars with two external, two internal, and two intermediate lobes, both the latter connected with the anterior internal by a ridge. Supposed inferior true molars with two Vs with weak anterior branches; last true molar with heel.

This genus will enter the *Chalicotheriidæ* of my system of *Perissodactyla,** if the feet are found to possess the requisite characters. It is allied, apparently, also to *Hyracotherium,* but differs in the Vs of the infe-

*See Proceedings Amer. Philosoph. Society, 1881, p. 377–8.

rior molars, if they are properly identified; and in the superior molars. The anterior transverse crest of that genus is represented in *Protogonia*, but not the posterior. This is replaced by a low ridge running across the course it pursues in *Hyracotherium*. The posterior median tubercle is also not found in the latter genus. *Protogonia* differs from *Limnohyus* in the subconic character of the external lobes of the superior molars. If the tubercles, excepting the posterior inner, should be converted into crescents, the genus *Meniscotherium* would be produced.

Char. Specif. Probably two specimens; one supporting three superior molars; the other including damaged superior molars and the last two inferior molars. The animal was about the size of the red fox. The external cusp of the fourth superior premolar is flattened externally, and has a small lobe on its posterior edge. The inner tubercle is conic and is separated by a tubercle from the anterior base of the external. True molars without external ridges. The external cusps of the true molars are lenticular in section. The posterior inner cusp is in nearly the same anteroposterior line with the anterior, its section about equaling that of the intermediate cusps. The first and second molars have an external, an anterior and posterior, but no internal, basal cingula. The enamel is somewhat wrinkled where not worn.

The heel of the last inferior true molar is elevated, and its worn surface forms the extended posterior branch of the posterior V. The posterior edge of the penultimate molar is elevated and curved forwards on the inner side of the crown. The anterior cusp forming the angle of the V of this tooth, is higher than the posterior angular cusp, but the anterior limb descends rapidly as in *Coryphodon*. A weak antero-external, and postero-external cingula. Enamel wrinkled where not worn.

Measurements.		M.
No. 1.		
Length of bases of three superior molars		.025
Diameters of superior P-m. IV	anteroposterior	.0066
	transverse	.0086
Diameters of superior M. I	anteroposterior	.0085
	transverse	.011
Diameters superior M. II	anteroposterior	.009
	transverse	.011
No. 2.		
Length of bases of last two inferior molars		.0225
Diameters of last inferior molar	anteroposterior	.0114
	transverse	.0066
Diameters of inferior M. II	anteroposterior	.0112
	transverse	.0080
Depth of ramus at M. II		.0240
Thickness " " "		.0110

MENISCOTHERIUM TERRÆRUBRÆ, sp. nov. My specimens of this species embrace the dentition of several individuals.

The dimensions of the superior molars increase to the penultimate, while the external and posterior sides of the last molar are contracted, reducing its size. The external faces of the external Vs of the true molars are considerably impressed; those of the premolars are nearly flat.

The second premolar is two-rooted, and has a compressed crown, without either heel or cingulum, except a thickening of the posterior base. The base of the crown is triangular. The external plate of the third premolar is simple, and is connected with the internal cusp by a cingulum on the posterior base of the crown. The crown is transverse, and the inner tubercle rather small. The fourth premolar is much larger than the third. Its external plate is divided into two apices, which are not impressed. Their external faces are separated by a faint ridge, and are divided medially by a faint ridge. The anterior external angle is rather prominent. The anterior and a posterior cingulum extend to and round the inner base of the interior tubercle. Within the anterior external apex, is a well developed intermediate crest parallel to it; and there is a corresponding crest within the posterior external apex. This one turns inwards at its posterior extremity, which is on the posterior cingulum.

The anterior angle or horn of each external crescent of the true molars is very prominent. They are sections of short vertical ridges, which unite near the base of the crown, giving abruptness to the impression of the external surface of the anterior lobe. The middle of each face has a faint median ridge. The two molars have an anterior basal cingulum, but no posterior or internal, excepting a trace between the bases of the internal lobes. The anterior intermediate crescent is quite parallel with the external; the anterior internal tubercle has a slightly V-shaped section. The posterior inner tubercle is quite confluent with an oblique intermediate crest, as in *M. chamense*. In the last true molar, as there is only one internal tubercle, this crest is short, terminating at the posterior border. The last true molar is like the last premolar, except in its two impressed external crescents.

A fragment of the right branch of the lower jaw supports two molars, and the alveoli of two others, all of which have two roots. These teeth are the four premolars, although the last one has the form of the first true molar. Should my surmise be correct, then the third premolar has nearly the same form and structure as the fourth. The anterior horn of its anterior V is not produced quite so far inwards as in the fourth tooth. At the point of junction of the adjacent horns of the Vs there is a slight antero-posterior extension, forming a median buttress of the inner side of the crown as in *Anchitherium*. The posterior horn of the posterior V is also incurved, as in that genus. The angles of the Vs of the inferior molars are rounded.

The surfaces of the enamel of the teeth of both jaws is smooth.

Measurements.	M.
Length of superior molars, less P-m. I	.046
" of true molar series	.028
" of base of P-m. II	.005

Measurements.		M.
Diameters of base P-m. III	anteroposterior	.006
	transverse	.007
" of base P-m. IV	anteroposterior	.008
	transverse	.010
" of base of M. II	anteroposterior	.011
	transverse	.013
" inferior P-m. III (or IV)	vertical	.005
	anteroposterior	.007
	transverse	.005
Depth of ramus at same tooth		.012
Thickness ramus at succeeding tooth		.009

The *Meniscotherium terrærubræ* differs from the *M. chamense* in two features. The first is its superior size. The second is the flattened form of the external faces of the true molars and the absence of the convexity of the external bases of the crown.

My specimen of this species is from the red Eocene bed in Northwestern New Mexico, from the true Wasatch horizon, or higher than that which produced the other species here described. It was found by my assistant, D. Baldwin.

REMARKS.

As stated in my report to Lieut. Wheeler in 1877, no vertebrate remains had been found in the Puerco beds, which underlie the Wasatch in New Mexico, up to that time. It was therefore uncertain whether they form the top of the Cretaceous or the bottom of the Tertiary series. I have recently obtained evidence of the existence of *Champsosaurus* in them, so that their position might be supposed to be in the Postcretaceous system.

It is however quite possible that the species of Mammalia described in this paper were derived from the Puerco Formation. Their horizon is below the Wasatch, and they represent a different fauna from that of those beds.

Attention has already been directed to this fauna in the pages of the *American Naturalist.** I have recorded the presence of the Creodont genera, *Periptychus*, *Triïsodon* and *Deltatherium*, and of the saurian *Champsosaurus*. I have now added the genera *Hyracotherium* and *Meniscotherium*, and a number of new forms of considerable interest. These are the Creodont *Mesonyx*, a new genus allied to *Esthonyx*, and a series of genera and species with a suilline type of dentition, but whose affinities are by no means certain. This point cannot be determined until the characters of the feet are known.

The facies of this fauna differs in several points from that of the Wasatch. *Coryphodon* has not yet been discovered in it, and the flesh-eaters are very primitive. The suilloid genera are characteristic.

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CONTRIBUTIONS TO THE HISTORY OF THE VERTEBRATA OF THE LOWER EOCENE OF WYOMING AND NEW MEXICO,

MADE DURING 1881.

By E. D. COPE.

(*Extr. Am. Phil. Soc.*)

(**Read before the Amer. Philosophical Society, Dec. 16, 1881.**)

FOR SALE BY A. E. FOOTE,
1223 BELMONT AVENUE,
PHILADELPHIA.

Contributions to the History of the Vertebrata of the Lower Eocene of Wyoming and New Mexico, made during 1881. By E. D. Cope.

(*Read before the American Philosophical Society, Dec. 16, 1881.*)

I. The Fauna of the Wasatch Beds of the Basin of the Big Horn River.

The basin of the Big-Horn river contains the most northern area of the deposits of the Wasatch or Suessonian epoch known. In order to ascertain whether the fauna it contains differs in any way from that I discovered in the corresponding beds of New Mexico in 1874, I sent, during the past season, an expedition, under the direction of J. L. Wortman, already known from his successful exploration of the Wind River basin in 1880. The present paper gives a review of the results of the season's work, prefaced by an account of the geology furnished by Mr. Wortman. The species herein described are being engraved for the fourth volume of Dr. Hayden's report of the United States Geological Survey of the Territories, now passing through the press.

1. *The Geology of the Big-Horn Basin, by Jacob L. Wortman.*

As early as 1859 Dr. Hayden described in detail the Tertiary sediment occupying the upper drainage basin of the Big-Horn river, which he determined as belonging to the lower Eocene formation, and applied the name Wind River group, from its being exposed along the Wind river, a name given to the upper portion of the Big-Horn. From an extensive collection of vertebrate fossils made by the writer at this horizon, during the summer of last year, Prof. E. D. Cope, for whom the collection was made, has, in a bulletin, U. S. Geol. Surv. Terrs., F. V. Hayden, Vol. vi, No. 1, 1881, confirmed this determination, and discussed at length the faunal relations they bear both to the Bridger and Wasatch beds respectively. The conclusions reached are, that this series is intermediate to a certain degree, containing genera hitherto regarded as peculiar to each. This upper basin covers quite an extensive area, and is bounded upon every side by lofty mountains. The Owl Creek mountains, which afforded a barrier to the waters of this Eocene lake on the north, has subsequently been cleft by the Big-Horn, leaving a deep and rough cañon, through which it now flows in its course north to the Yellowstone. After passing the Owl Creek mountains it emerges into a second or lower basin, commonly called the Big-Horn basin proper. This one covers a much larger area than the upper, and like it is walled in by mountain ranges, and filled with a mass of sedimentary rock which is also referable to the lower Eocene series.

During the summer of the present year the writer has been engaged in further exploration of this interesting region, which resulted in the collection of a large number of extinct vertebrates, obtained exclusively from the lower Eocene horizon of the Big-Horn, and which have all been sub-

mitted to Prof. Cope, at whose instance the party was organized and equipped.

Dr. Hayden has made the observation that upon the eastern slope of the Wind River mountains all the corresponding strata are visible from the Silurian to the Cretaceous; this is also true of the northern slope of the Owl Creek mountains, while the southern side does not exhibit such continuity of structure. Upon entering the basin from the south, the older formations are seen to extend towards its centre for a distance of ten miles, inclining at an angle of 30° to the north, while the level of the Tertiary has been little or not at all disturbed since its deposition. That this basin contained a separate and isolated body of water, limited by its present boundaries, which were outlined about the beginning of the Wasatch epoch, there is every reason to believe. A section made by the Big-Horn at the southern extremity shows the Tertiary to rest unconformably upon a thick mass of buff colored sandstone, rather coarse in texture, somewhat laminated, and towards the bottom interspersed with thin layers of impure lignite varying from six inches to one foot in thickness. This sandstone most probably belongs to the Laramie series, but in the absence of fossils the determination is by no means satisfactory.

The Eocene sediment covers a large part of the basin, and cannot be less than 4000 feet in vertical depth. This mass, once continuous over a large area, has since been carved and weathered into many fantastic and remarkable forms, presenting at once a bold and striking appearance, a characteristic feature of the western Tertiary bad lands.

Beginning at the southern limit at a point opposite the mouth of Meyers creek, on the east side of the river, a series of low bad land bluffs, facing to the west and gradually becoming higher as they proceed, describe a gentle curve to the north, terminating at the river's edge 30 miles below. The character of the country between the river and these bluffs is a barren sage brush plain, while back of the bluffs a high mesa occupies the country for many miles. On the west side, numerous rivers, creeks, and their tributaries, putting down from the Sierra Shoshone range, have excavated the mass in every direction, leaving bold escarpments, high bad land buttes, elevated tables, with innumerable gulches and ravines. Country of this character stretches far away to the northern limit, near the Big Horn gap, presenting that desolate and sombre appearance, so often met with in bad land regions,

Its composition may be described as consisting of various colored clays alternating with layers of brown and blue sandstone, although that evenness of stratification by which a single layer of either, in one part, could be identified in another, does not exist. Those exposures, for example, on the east side of the Big-Horn are highly arenaceous, the clay and sand existing in almost equal proportions, while in the exposures along the Grey Bull river, and in the vicinity of Coryphodon butte, the quantity of sand is greatly diminished, and is found in separate layers. The preponderance of the red clay is a marked feature, and has called forth the

remark from Dr. Hayden, relative to the sediment of the upper basin, "that they remind one of the Jura Trias red beds." This remark is forcibly illustrated by the character of the sediment found in the south-western part of the basin, near the head of Gooseberry creek, where the exposures consist largely of thick strata of the red clay, which gradually thin out to the north and east, blending with the pink, blue, and buff colors. In the northern part of the basin, and along Stinking river, the sediment consists almost exclusively of a pale yellow sandstone of a bluish tinge, from which few fossils were obtained.

The clays contain much lime in the form of small limestone nodules of a rusty brown appearance, in which the fossils are often found, having a thin and intensely hard layer of ferrous oxide investing them externally. In the red the fossils are always scarce and fragmentary, and when found are usually such parts as would, under the most favorable circumstances, be preserved. The blue seems to be the more productive, and to have offered better conditions for their preservation ; but, owing to the fact that lime forms the petrifying base, and being less able to withstand the heavy pressure than many other materials, the fossils from both the red and the blue are, as a general rule, greatly distorted and crushed. This fragmentary occurrence of fossils in the fine-grained clay, I am inclined to believe, is due, not to a scattering of the bones by currents, but rather to imperfect and unfavorable conditions for their preservation. That entire skulls and skeletons were deposited, where now nothing but the teeth remain, I am well satisfied from the circumstance that both superior and inferior series are not unfrequently found in proper position without a trace of ramus or cranium. In the sandstones, however, the fossils are in a magnificent state of preservation, but their extreme scarcity in this material gives the collector many long and fruitless searches. Two skeletons which have proven of considerable interest were all of any consequence that were obtained from the sandstones.

The general stratigraphical appearance, as well as the scattered and fragmentary condition of the fossils, together with the community of a large number of genera, refer it to the Wasatch epoch, but a full discussion of this point belongs properly to the paleontologist. A thorough elucidation will be found in Prof. Cope's paper on the fossils.

The exploration of this region is most arduous and difficult. The great scarcity of water in these bad land wastes, makes it very inconvenient, and renders it necessary to carry a water supply a distance of often 20 miles or more. Even when water does exist it is so strong with alkali as to be scarcely fit for use. Many of the streams coming down from the mountains dry up as soon as the snow has melted from the low foot hills in early spring, leaving large tracts entirely destitute of water, which frequently abound in fossiliferous exposures, and which it is the object of the explorer to examine. The broken and mountainous character of the country forbids the use of wagons to such an extent that pack animals are indispensable.

The accompanying map is intended to illustrate the exact position, as well as the extent of country covered by the Wasatch sediment at this point. Its topography is taken from a map made by Capt. J. Russell, Third Cavalry, U. S. A. (and published by the War Department), during a reconnoissance of that region in the summer of 1880, and to whom, as well as Dr. W. H. Corbusier, Col. J. W. Mason, and other officers stationed at Fort Washakie, I wish to express my deep sense of obligation for their very kind and courteous treatment.

Map of the Big-Horn Basin, reduced from the Map of the U. S. War Department.

2. *Synopsis of the Fauna.*

PISCES.

Clastes sp. ; not abundant.

Pappichthys sp. Vertebræ ; not very common.

REPTILIA.

Crocodilus sp. Allied to the *C. chamensis* and *C. heterodon*, but not represented by sufficiently well preserved specimens to permit of determination. There are numerous molariform teeth in the posterior parts of jaws, and the crowns of the longer teeth are grooved. Not uncommon.

Emys sp. Rare; one specimen of 220 mm. in length, of the type of *E. wyomingensis*, but not sufficiently well preserved for determination.

As the Eocene forms of this order are of unusual interest, I give an analysis of the extinct genera of the Cryptodire division of tortoises which have been found in North America up to the present time.

In the check-list of the North American *Batrachia* and *Reptilia*,* I enumerated nine families of this division of the *Testudinata*, three of which are extinct. Subsequently another extinct family, the Baënidæ, was added. I now define all of these families.

I. Plastron not articulated to the carapace, but presenting to it more or less open digitations. *Dactylosterna.*

Phalanges of anterior limb without condyles, and covered by a common integument; eight pairs of costal bones.................. *Cheloniidæ.*

Phalanges of anterior limb without condyles; nine or more costal bones, *Propleuridæ.*

Phalanges of anterior limb with condyles; digits inclosed in distinct integuments; eight costal bones; sternal elements united by digitations and inclosing fontanelles; caudal vertebræ procoelous... *Trionychidæ.*

Phalanges of anterior limbs with condyles; digits distinct; eight costal bones; sternal elements united by suture and inclosing no fontanelles; caudal vertebræ opisthocoelous.......................... *Chelydridæ.*

II. Plastron uniting with the costal bones of the carapace, by denticulate suture, and by ascending axillary and inguinal buttresses. (Feet ambulatory.) *Clidosterna.*

A. Intersternal bones present.

No intergular scuta.. *Pleurosternidæ.*†

Intergular scuta; caudal vertebræ opisthocoelous............... *Baënidæ.*

AA. No intersternal bones.

a. Intergular scuta.

A mesosternal bone.. *Adocidæ.*

aa. No intergular scuta.

A mesosternal bone; three series of phalanges................. *Emydidæ.*

No mesosternal bone; three series of phalanges............ *Cinosternidæ.*

A mesosternal bone; two series of phalanges................ *Testudinidæ.*

* Bulletin U. S. National Museum, No. 1, 1875. p. 16.

† There are two genera of this family, neither of them yet found in America; *Pleurosternum* Ow., with smooth shell, and *Helochelys* Myer, with sculptured shell.

III. Plastron uniting with the marginal bones of the carapace by straight contact only. (Feet ambulatory.) *Lysosterna.*

No intersternal bone nor intergular scutum ; a mesosternal bone and three series of phalanges..*Cistudinidæ.*

The extinct species of the *Cryptodira* of this continent belong to eight of the above families. I give diagnoses of the genera to which they are referred. Names of existing genera are in Roman type.

CHELONIIDÆ.

Postabdominal bones distinct from each other...........Chelonia Brong.
Postabdominal bones united with each other by suture..*Puppigerus* Cope.

PROPLEURIDÆ Cope.*

Transactions of American Philosophical Society, xiv., 1870, p. 235.

Ten costal bones ; first two marginals united with carapace by suture ; shell smooth, flattened.............................*Osteopygis* Cope.

Nine costal bones ; first two marginals united to carapace by suture ; shell sculptured (a high dorsal keel)..... ....*Peritresius* Cope.

Nine costal bones ; one marginal united with carapace by suture ; second by costal gomphosis ; shell not keeled nor sculptured .... *Propleura* Cope.

? Nine costal bones ; first united with carapace by suture ; second without costal gomphosis ; shell not sculptured............*Catapleura* Cope.

? Nine costal bones ; marginals all free ; shell not sculptured............ *Lytoloma* Cope.

TRIONYCHIDÆ.

a. Surface of bones smooth.

Postabdominal suture digitate ....*Axestus* Cope.

aa. Surface of bones sculptured.

β. Sutures of plastron digitate.

A dermal flap protecting posterior legs below ; marginal bones........... Emyda Gray.

A dermal flap ; no marginal bones................Cyclanosteus Peters.

No dermal flap nor marginal bones ; muzzle much abbreviated.......... Chitra Gray.

No dermal flap nor marginal bones ; muzzle elongate....Trionyx Geoffr.

ββ. Suture for postabdominal coarsely serrate.

Postabdominal recurved in front.......................*Plastomenus* Cope.

CHELYDRIDÆ.

a. Bridges of plastron wide ; ? caudal vertebræ.

One row of marginal scuta ; six pairs of scuta of the plastron........... *Idiochelys* Myr.

* *Palæochelys novemcostatus* Geoffr., belongs to this family, but not *Palæochelys* Myr.

One row of marginal scuta ; scuta of plastron ? not distinct.................
*Hydropelta** Myr.

aa. Bridges of plastron very narrow.

β. Carapace smooth, not sculptured.

Two rows of marginal scuta ; five pairs of scuta of the plastron...........
Macrochelys Gray.

One row of marginals ; five pairs on plastron............Chelydra Schw.

One row of marginals ; four pairs of scuta on plastron....Claudius Cope.

ββ. Carapace sculptured.

One row of marginal scuta.............................*Anostira* Leidy.

Baënidæ.

Cope, Annual Report U. S. Geol. Surv. Terrs., 1872 (1873), p. 621.

Supramarginal scuta (Rütimeyer) ; no interhumerals.....*Platychelys* Myr.

No supramarginals nor interhumeral scuta...............*Baëna* Leidy.

No supramarginals ; interhumeral scuta present ......*Polythorax* † Cope.

Adocidæ.

Cope, Proceedings American Philosophical Society, 1870, p. 559.

a. Vertebral bones and scuta normal.

One intergular scutum entirely separating the gulars.......*Adocus* Cope.

Either two intergulars, or the gulars meeting behind intergular..........
Amphiemys Cope.

aa. Vertebral bones wedge-shaped, widening upwards ; vertebral scuta not wider than the bones.

Elements of carpace early coössified.................*Homorhophus* Cope.

Emydidæ.

a. No scutal sutures.

Surface sculptured.....................................*Apholidemys* Pom.

aa. Scuta including intermarginals and two anals.

Lobes of sternum narrow...............................Dermatemys Gray.

Lobes of sternum wide.................................*Agomphus* Cope.

aaa. Scuta ; two anals, no intermarginals.

Surfaces of carapace sculptured ; plastron fixed......*Compsemys* Leidy.

Surfaces of carapace smooth ; plastron fixed ; recent *Emydidæ* and the genus..Emys Brong.‡

Posterior lobe of plastron movable ; surface smooth....*Ptychogaster* Pom.

Anterior and posterior lobes of plastron movable ; surface smooth........
Dithyrosternum Pict. et Humb.

aaaa. Scuta ; one anal, no intermarginals.

Carapace smooth ....*Stylemys* Leidy.

* *Eurysternum* Wagn. (*Palæomedusa* et *Acichelys* Myr. (fide Rütimeyer) is nearly allied to *Hydropelta.*)

† Possibly one of the *Adocidæ;* see Proceed. Acad. Phila., Oct., 1876.

‡ Gray has distinguished several good genera among existing species on cranial characters.

TESTUDINIDÆ.

a. Two anal scuta.

Ten abdominal scuta...................................*Hadrianus* Cope.

aa. One anal scutum.

Lower jaw with two cutting edges....................Xerobates Agass.
Lower jaw with one cutting edge.......................Testudo Linn.

RODENTIA.

PLESIARCTOMYS BUCCATUS Cope.

Two mandibular rami.

PLESIARCTOMYS DELICATIOR Leidy.

Mandibles of six individuals, some of them accompanied by bones of the skeleton.

BUNOTHERIA.

TÆNIODONTA.

Additional material gives the following results with regard to the affinities of this sub-order. There are three allied groups represented by the genera *Esthonyx*, *Tillotherium* and *Calamodon* of the American Eocenes, which are equally unlike each other. *Esthonyx*, as I long since showed, is related to the existing *Erinaceus;* very nearly indeed, if the dentition alone is considered. Its anterior incisor teeth are unusually developed, and have, as in *Erinaceus*, long roots. One pair at least in the lower jaw has enamel on the external face only, and enjoys a considerable period of growth. The genus *Tillotherium* is (fide Marsh) quite near to *Esthonyx*. Its molars and premolars are identical in character with those of that genus, the only important difference being found in the incisors. Here, one pair above, and one pair below, are faced with enamel in front only, and grow from persistent pulps as in the *Rodentia*. This character has been included by Marsh in those he ascribes to his "order" of *Tillodontia*, but as he includes *Esthonyx* in that order,* which does not possess the character, it is not very clear on what the supposed order reposes. The rodent character of the incisors is the only one that I know of which distinguishes *Tillotherium* from the *Inesctivora*. I have on this account retained the *Tillodonta* as a sub-order, and referred *Esthonyx* to the *Insectivora*.

The *Tæniodonta* agree with the *Tillodonta* in the possession of a pair of inferior incisors of rodent character, but it adds several remarkable peculiarities. Chief among these is the character of the inferior canines. In the *Tillodonta* they are either wanting, as in *Erinaceus*, according to the Cuvierian diagnosis, or they are insignificant. In *Calamodon* they are of large size, and though not as long-rooted as the second incisors, grow from presistent pulps. They have two enamel faces, the anterior and the posterior, the former like the corresponding face of the rodent incisors.

* Report of U. S. G. Survey 40th Parallel, by Clarance King; Vol. i, p. 377.

The function of the adult crown is that of a grinding tooth. This character distinguishes *Calamodon* as a form as different from *Tillotherium*, as the latter is from *Esthonyx*. There are, however, other characters. The external incisors, wanting in *Tillotherium*, are here largely developed, and though not growing from persistent pulps have but one, an external band-like enamel face. Their function is also that of grinders.

The fact that the rodent teeth in the lower jaw are the second incisors, renders it probable that those of the *Tillodonta* hold the same position in the jaw. This is to be anticipated from the arrangement in *Esthonyx*, where the second inferior incisors are much larger than the first and third. The superior dentition of the *Tæniodonta* is yet unknown.

CALAMODON SIMPLEX Cope.

Report Vertebrate Foss., New Mexico, U. S. Geog. Surv. W. of 100th Mer. 1874, p. 5. Report of do. Capt. G. M. Wheeler, IV, ii, p. 166.

A nearly complete mandible of this species was found by Mr. Wortman, besides a series of unworn molar and canine teeth of a second individual, and fragments of some others. These furnish the correct dental formula as far as they go, as follows : I. 3 ; C. 1 ; M. 5. It appears that I correctly referred the long rodent teeth to the lower incisior series, but that the truncate two banded teeth so characteristic of the sub-order, are canines and not incisors, and that they belong to the lower as well as probably to the upper jaw.

The characters of the incisors are very peculiar. The first are small with short subcylindric crowns, and conic roots. The second incisors have been described ; as in *C. arcamœnus* they have a horizontal shoulder posterior to the base of the cutting portion. The third incisors increase in diameter upwards, and have a triangular section. The largest side of the triangle is interior, and the shortest the posterior, and neither possess any enamel. The anterior or enamel faced side is slightly convex. The grinding face is transverse and is in the plane of the corresponding face of the canine. The long diameter of the crown of the canine is at right angles to the anterior face of the third incisor, and diagonal to the long axis of the mandibular ramus. This, with the peculiarities of the other incisors, gives an irregular appearance to the anterior dentition.

The five molars are very similar in character, and even those with unworn crowns do not present any distinction into premolars and true molars. The enamel covers the summit of the crown, but on wearing, it is soon reduced to a cylindrical sheath. Further wear brings the grinding surface to the anterior and posterior surfaces which are covered with cementum instead of enamel.

INSECTIVORA.

ESTHONYX BURMEISTERI Cope.

Report Vertebrate Foss., New Mexico, 1874, p. 7. Report U. S. G. G. Surv. W. of 100th Mer. G. M. Wheeler, IV, ii, p. 156, pl. XI, fig. 26.

Two fractured crania exhibit the entire dentition of this species, and give the generic characters satisfactorily. The dental formula is, I. $\frac{2}{3}$; C. $\frac{1}{1}$; P-m. $\frac{?\,3}{3}$; M. $\frac{3}{3}$. The first superior incisor is large, and the crown is somewhat spoon-shaped. The second incisor is as robust as the first, but the crown is shorter. The second premolar has one external and one internal lobe, in the third (fourth) premolar these lobes are much enlarged, and the tooth is transverse. The true molars have two external cusps, which are flattened, close together, and well within the margin of the base of the crown. There is one internal lobe and a strong posterior ledge, as in the opossums. Of the inferior incisors, the median is large and half gliriform, while the first and third are small. The inferior, like the superior canines, are large. The first and second (third) premolars have no internal lobes, but the second (third) has a heel. The fourth is more or less like the first true molar.

The specimens show that my original determinations of the incisors based on loose teeth were correct. They also show that this genus is not far removed from the more rodent-like genus *Anchippodus* of Leidy.

There are several species of the genus, which I define as follows:

I. Fourth inferior premolar like first true molar.

Larger; third superior premolar larger; fourth premolar with the external cusp bilobate..*E. acutidens.*

Medium; third superior premolar smaller; fourth premolar with external cusp simple; superior incisors wide; large inferior narrower........ *E. burmeisteri.*

Medium; superior incisors narrow; large inferior wider....*E. bisulcatus.*

II. Fourth inferior premolar with anterior V open and cutting.

Smallest; incisors unknown.................................*E. acer.*

A species of the size of *E. acer* has been named *E. spatularius*, but I cannot place it in the above key, as the premolar and incisor teeth are unknown. The section II, approximates nearer the genus *Conoryctes* than sect. I.

MESODONTA.

HYOPSODUS LEMOINIANUS, sp. nov.

This Mesodont is distinguished from the known species of the genus by its superior size, and the fully developed heel of the inferior third molar. The anterior inner cusps of the inferior molars are absolutely simple, and the same teeth have a weak external and no internal cingulum. The cusps are elevated and the enamel smooth.

The species of this genus known to me by their mandibles are four, and these differ chiefly in size. Their characters are as follows:

Length of true molars M. .0165; last molar elongate.....*H. lemoinianus.*

Length of true molars M. .0140; last molar longer than second.......... *H. paulus.*

Size as last ; last molar shorter than second.................*H. miticulus.*
Length of true molars M. .0115 ; last molar elongate.........*H. vicarius.*

H. lemoinianus and *H. miticulus* have not been found out of the localities where they were discovered, while the other two species are distributed through most of the Eocene horizons, and have been found in many localities. Of the *H. lemoinianus* Mr. Wortman found nine more or less fragmentary mandibles.

Dedicated to my friend, Dr. Victor Lemoine of Reims, well-known for his brilliant discoveries in the vertebrate paleontology of the Lower Eocene beds near that city.

HYOPSODUS PAULUS Leidy.

Thirty-eight more or less broken mandibular rami.

HYOPSODUS VICARIUS Cope.

Eleven mandibular rami. A few specimens are intermediate between this species and the last in dimensions, the inferior true molars measuring M. .0120 and .0125 in length.

PANTOLESTES CHACENSIS Cope.

Four mandibular rami. This species has the fourth premolar more robust and less trenchant than in *P. secans*, and shorter than the last true molar. In *P. secans* it is longer than the last true molar.

PANTOLESTES METSIACUS sp. nov.

A small species of the size of the *P. longicaudus*, and distinguished by several peculiarities of dentition. The two cusps composing the anterior internal lobe of the molars are quite distinct but appressed. Each one is connected with the external anterior lobe by a transverse crest as is seen in *Esthonyx*, and these enclose between them a fossa. This fossa is closed internally by the appression of the anterior inner cusps. The fourth premolar is not so large as in *P. secans*, but resembles in proportions that of *P. chacensis*. It differs from that of *P. longicaudus* in its very short heel and its large anterior basal tubercle. The latter is double, consisting of two small cusps, one within and anterior to the other. The posterior heel is distinct on both sides of the ridge that marks the median line. The posterior external lobe is V-shaped, and the posterior inner is a small cone. Between the two is a minute median tubercle. The posterior tubercles are not so elevated as in the species of *Hyopsodus*. A weak external cingulum ; enamel smooth.

Measurements.	M.
Length P-m. IV, with M. I, and II ; (No. 1)..........	.0140
" P-m. IV....................................	.0048
" M. II......................................	.0043

Measurements.	M.
Width M. II	.0040
Length M. III; (No. 2)	.0050
Width "	.0030
Depth ramus at P-m. IV ; (No. 1)	.0060
" " M. III; (No. 2)	.0070

Portions of four mandibles preserved. No. 2 is a little smaller than No. 1, and No. 4 is a little larger than No. 1.

The species of *Pantolestes* may be distinguished as follows :

a. Fourth premolar trenchant everywhere, longer than second molar. Length of true molars M. .0150 ; second molar with but one anterior inner cusp....................................*P. secans.*

aa. Fourth premolar with blunt heel, not longer than second molar.
Length of true molars .0160 ; all with double cusps..........*P. chacensis.*
Length of true molars .0140 ; fourth premolar with minute anterior cusp, and long heel..*P. longicaudus.*
Length of true molars .0130 ; fourth premolar with double anterior cusp, and short heel ; molars with double cusps................*P. metsiacus.*
Length of true molars .0105 ; fourth premolar small, .0035, without anterior cusps, and with two ridges on heel ; true molars with double anterior inner cusps..*P. nuptus.*

PANTOLESTES NUPTUS, sp. nov.

This is the last species of the genus, and is represented by a portion of a right mandibular ramus which supports three molars from the fourth to the sixth inclusive. Besides its small size, this species is distinguished by the relatively small dimensions of the fourth premolar, which is shorter than the first true molar instead of longer, as in all the other species. The well developed basin of its heel, which is bounded by a ridge on each side, distinguishes it at once also from *P. secans,* and is more distinct than in *P. chacensis ;* from the latter and *P. metsiacus* the entire absence of anterior basal lobes separates it. The well developed pair of anterior inner tubercles of the true molars shows that it cannot be an abnormal *Hyopsodus vicarius,* with which it agrees in size. The first anterior tubercle is more widely separated from the second anterior than in any of the species of the genus, and is quite as in species of *Pelycodus.* It is smaller than the second anterior inner, which equals in size the anterior outer. The heel is wide, enclosing a basin, which is bounded externally by an angular ridge. Its posterior inner angle supports a cusp, which is separated by a deep notch from the anterior inner cusp. External to it on the posterior border of the crown is a small tubercle. No basal cingula.

Measurements.		M.
Length of three molars		.010
Diameters of M. i	anteroposterior	.004
	transverse	.003
Depth of ramus at P-m. IV		.007

Basin of the Big-Horn ; J. L. Wortman.

Pelycodus angulatus Cope.

The species of this genus are, in the present state of our knowledge, best distinguished by their size.

Length of true molars on base	M. .024 ;	*P. pelvidens.**
" " " "	M. .019 ;	*P. jarrovii.*
" " " "	M. .017 ;	*P. tutus.*
" " " "	M. .015 ;	*P. frugivorus.*
" " " "	M. .012 ;	*P. angulatus.*

Remains of species of this genus are very common in the Wind River bad lands ; they were originally found in the Wasatch beds of New Mexico, and have not yet been announced from the Bridger formation.

The *P. angulatus*, heretofore only known from New Mexico, is represented in the Big-Horn collection by five mandibular rami, and a portion of a maxillary bone with teeth.

Pelycodus frugivorus Cope.

Two mandibles and seven separate rami represent this Mesodont.

Pelycodus tutus Cope.

Four rami display the typical length of the true molars, M. .017. Three are smaller, having the molars .016 in length, while one gives .018 for the same teeth. Other portions of the skeleton will be necessary to determine exactly the specific position of these specimens.

Prosimiæ.

Cynodontomys latidens, gen. et sp. nov.

Char. gen. Derived from mandibular rami. Dental formula I. ? 0 ; C. 1 ; P-m. 2 ; M. 3. The premolars are counted as two, on the supposition that the anterior one is two-rooted ; should it prove to be one-rooted, then the number will be three. The canines are very large and close to the symphysis, so that there do not appear to have been any incisors. The true molars have the frequently occuring three tubercles in front and a heel behind ; but the arrangement is peculiar in that the three tubercles are but little more elevated than the borders of the heel, and occupy a small part of the crown. The last molar is lost from both jaws, but the space for it is about as large as that occupied by the penultimate. The fourth premolar has but two anterior cusps, and these are more elevated than those of the true molars, and the heel is narrower. The mandibular rami are not coössified.

The dental characters of this genus resemble considerably those of *Anaptomorphus* and *Necrolemur*, but the large size of the inferior canine tooth distinguishes it from both. The double anterior cusps of the fourth premolar equally distinguish it from them.

Char. Specif. The inferior true molars are subquadrate in horizontal outline, somewhat narrowed anteriorly. The concave heel is the larger part of the crown ; it is only elevated into a low cusp at the posterior external angle. The anterior cusps are conic, and are in contact at the

* *Lipodectes pelvidens* Cope, Amer. Naturalist, Dec., 1881, p. 1019.

base. The external and posterior internal are of about the same size; the anterior inner is smaller and does not project so far inwards as the posterior. The fourth premolar has the posterior border of its heel serrate. The anterior cusps are elevated and moderately acute; the internal is a little less elevated than the external, and is separated from it by a deep notch. The alveoli for the anterior premolar are so close together, as to render it probable that they belong to but one tooth. They are placed somewhat obliquely to the long axis of the jaw. There is no diastema. The section of the base of the crown of the canine is a regular oval, the long diameter coinciding with the vertical diameter of the ramus.

The ramus is rather slender, but is shortened anteriorly. The boundaries of the masseteric fossa are well marked, the anterior ridge descending to below the middle line of the ramus. The mental foramen is large and is situated below the contact of the two premolars. The inferior edge of the ramus is rather thick.

Measurements.		M.
Length of dental series including canine		.0240
" premolars		.0062
" molars		.0114
Long diameter base canine		.0036
Diameters P-m. IV	anteroposterior	.0038
	transverse	.0026
" " M. II.	anteroposterior	.0042
	transverse	.0038
Depth of ramus at P-m. I		.0060
" " " M. III		.0068

ANAPTOMORPHUS HOMUNCULUS Cope, American Naturalist, 1882, Jan. (Dec. 30th, 1881), p. 73.

The genus *Anaptomorphus* was characterized by me in 1872,* from a mandibular ramus which exhibited the alveoli of all the teeth, three of them occupied by the teeth; viz.: the P-m. iv, and the M. i and M. ii. From the specimen the inferior dental formula was ascertained to be I. 2; C. 1; P-m. 2; M. 3. The Big-Horn collection contains a nearly entire cranium of what is probably a species of the same genus. From it the superior dentition, exclusive of the incisors, is determined to be: C. 1; P-m. 2; M. 3. The premaxillary bones are mostly broken off, but a part of the alveolus of the external incisor of one side remains.

The indications are that the external incisor was a small tooth, not exceeding the canine in size; and it was situated close to the latter. The canine is also small, and its simple crown is not more prominent than those of the premolars. The latter are separated from it by a very short diastema. The long diameter of their crowns is transverse to the long axis of the

* Proceedings American Philosophical Society, 1872, p. 554. Paleontological Bulletin, No. 8, p. 1, Oct. 12, 1872.

jaw ; and each one consists of a larger external, and smaller internal cusp. The true molars are also wider than long, and support two external and only one internal cusps.

The orbits are large and are entirely enclosed behind. The frontal bone does not send inwards to the alisphenoid a lamina to separate the orbit from the temporal fossa, as is seen in *Tarsius.* There is no sagittal crest, but the temporal ridges are distinct. The occipital region protrudes beyond the foramen magnum, or at least beyond the paroccipital process, which is preserved, the condyles being lost. The otic bulla is large, extending anteriorly to the glenoid cavity. The pterygoid fossa is large, the external pterygoid ala being well developed, and extending well upon the extero-anterior side of the bulla, as in *Tarsius.* As in that genus, the foramen ovale is situated on the external side of the bulla, just above the base of the external pterygoid ala. The carotid foramen, as I suppose it to be, is situated at the apex of the bulla. The lachrymal foramen is situated anterior to, and outside of the orbit as in *Lemuridæ* generally.

The cast of the anterior part of the left cerebral hemisphere is exposed. This projects as far anteriorly as the middle of the orbits, leaving but little room for the olfactory lobes. The relations of the latter as well as of other parts of the brain will be examined at a future time. The part exposed does not display fissures, and gentle undulations represent convolutions.

The characters of this genus now known, warrant us in thinking it one of the most interesting of Eocene Mammalia. Two special characters confirm the reference to the *Lemuridæ* which its physiognomy suggests. These are, the external position of the lachrymal foramen, and the unossified symphysis mandibuli. Among *Lemuridæ,* its dental formula agrees only with the *Indrisinæ,* which have, like *Anaptomorphus,* two premolars in each jaw. But no known *Lemuridæ* possess interior lobes and cusps of all the premolars, so that in this respect, as in the number of its teeth, this genus resembles the higher monkeys, the *Simiidæ* and *Hominidæ,** more than any existing member of the family. Of these two groups the resemblance is to the *Hominidæ* in the small size of the canine teeth. It has, however, a number of resemblances to *Tarsius* which is perhaps its nearest ally among the lemurs, although that genus has three premolars. One of these points is the anterior extension of the otic bullæ, which is extensively overrun by the external pterygoid ala. A consequence of this arrangement is the external position of the foramen ovale, just as is seen in *Tarsius.* Another point is the probably inferior position of the foramen ovale. Though this part is broken away in the cranium of *Anaptomorphus homunculus,* the paroccipital process is preserved, and has the

* In an early description of *Anaptomorphus,* Proc. Amer. Philos. Soc., 1873, the types make me say "this genus * * might be referred decidedly to the *Lemuridæ,* were it not for the unossified symphysis." It is scarcely necessary to state that *Simiidæ* should be read in place of *Lemuridæ.*

position seen in *Tarsius*, as distinguished from the *Indrisinæ, Lemurinæ, Galaginæ*, etc. In this it also resembles the true *Quadrumana*.

When we remember that the lower *Quadrumana*, the *Hapalidæ* and the *Cebidæ*, have three premolar teeth, the resemblance to the higher members of that order is more evident. The brain and its hemispheres are not at all smaller than those of the *Tarsius*, or of the typical lemurs of the present period. This is important in view of the very small brains of the flesh-eating and ungulate Mammalia of the Eocene period so far as yet known. In conclusion, there is no doubt, but that the genus *Anaptomorphus* is the most simian lemur yet discovered, and probably represents the family from which the true monkeys and men were derived. Its discovery is an important addition to our knowledge of the phylogeny of man.

Char. specif. The specimen is distorted by pressure, but its form is normally nearly round, when viewed from above or below. The extremity of the muzzle is broken away, but the alveolus of the external incisor indicates that it is short, and not prolonged as in *Tarsius spectrum*. The mandibular ramus, already described, proves the same thing. The orbits are large, but not so much so as in *Tarsius spectrum*; their long diameter equals the width of the jaws at the last superior molar teeth inclusive. The supra-orbital borders project a little above the level of the frontal bone, which is concave between their median and anterior parts. The cranium is wide at the postorbital region, in great contrast to its form in the *Adapidæ*, resembling the *Necrolemur antiquus* Filh. in this respect. The postfrontal processes are wide at the basal portion, and flat. From their posterior border the temporal ridges take their origin. These converge posteriorly and probably unite near the lambdoidal suture, but this part of the skull is injured. The anterior lobes of the cerebral hemispheres are indicated externally by a low boss on each frontal bone.

The paroccipital process is short and wide at the base, and it is directed downwards and forwards. The alisphenoid descends so as to form a strong wall on the anterior external side of the otic bulla. This is also the case in *Tarsius spectrum*, but in the extinct species the descending ala is more robust, and has a thickened margin. On the latter the external pterygoid ala rests by smooth contact of its thickened superior edge. This ala is twice as prominent as the internal pterygoid ala. The posterior nareal opening is not wide, and its anterior border is parallel with the posterior border of the last superior molar teeth. The palate is wide, and its dental borders form a regular arcade as in man, being quite different from the form usual in monkeys and lemurs, including *Tarsius*. Perhaps the form is most like that of *Microrhynchus laniger*. The proximal parts of the malar bone are prominent, and overhang the maxillary border, as in *Tarsius*.

The *foramina ovale* and *lachrymale* are rather large. There are two infraorbital canals, lying beside each other, and issuing by two foramina externa. The external appearance justified this conclusion, but the fact

was demonstrated when I accidently broke away the anterior border of one of the orbits. This displayed the two canals filled with matrix their entire length. The anterior foramen externum is anterior to and above the posterior, and both are above the first (third) premolar tooth. The lachrymal foramen is above the space between that tooth and the canine.

The crown of the canine tooth is a cone with a very oblique base, and a convex anterior face. The base rises behind, and the posterior face has on the median line a low angular edge. The internal cone of the third (first) premolar is not so prominent as that of the second, though large. The external cusps of both premolars rise directly from the external base. They are flattened cones, with anterior and posterior cutting edges. The crowns are a little contracted at the middle, so as to be narrower than the inner lobe of the tooth, which is narrower than the external portion. Both premolars have delicate anterior, posterior and external cingula. The external cusps of the true molars rise directly from the external base, and like those of the premolars, have a regularly lenticular section. At the internal base of each one is a small intermediate tubercle, which is connected by an angular ridge with the single internal cusps. There are delicate anterior, posterior, and external cingula, but no internal. The posterior cingulum shows a trace of enlargement at its inner part, which is well marked on the second molar, but it is not as prominent as in many Creodont genera. The posterior external cusp of the last true molar is reduced in size. Taking the molars together, the first true molar is the largest, and they diminish in size both anteriorly and posteriorly. The third true molar is a little smaller than the first (third) premolar. Enamel smooth.

Measurements.		M.
Length of cranium to occipital prominence above paroccipital process, and minus premaxillary bone		.0280
Total width at posterior border of orbit, below		.0240
Length of palate from front of canine tooth		.0116
Width of palate and peunltimate molars		.0125
Length of superior molar series		.0095
" " true molars		.0060
Diameters of crown of canine	anteroposterior	.0018
	vertical	.0018
Diameters crown of P-m. iii,	anteroposterior	.0020
	transverse	.0026
Diameters crown of P-m. iv,	anteroposterior	.0020
	transverse	.0035
Diameters M. ii,	anteroposterior	.0032
	transverse	.0040
Diameters M. iii,	anteroposterior	.0016
	transverse	.0028
Diameters of orbit	anteroposterior	.0110
	vertical (? depressed)	.0078
Interorbital width (least)		.0050

The *Anaptomorphus homunculus* was nocturnal in its habits, and its food was like that of the smaller lemurs of Madagascar and the Malaysian islands. Its size is a little less than that of the *Tarsius spectrum.* The typical specimen was found by Mr. J. L. Wortman in a calcareous nodule in the Wasatch formation of the Big-Horn basin, Wyoming Territory.

Creodonta.

Shortly after the publication of my arrangement of the Creodonta in 1880*, I obtained a good deal of additional material, which enabled me to improve it in several respects. A number of genera have been added, and the characters which distinguish the *Miacidæ* and *Oxyænidæ* have been more fully brought out. The *Miacidæ* differ from all other families in having the fourth superior premolar sectorial as in the true *Carnivora,* while the true molars are tubercular. In *Oxyæna,* the fourth superior premolar displays no indication of sectorial structure, the first true molar assuming that character. In *Stypolophus* and allies, the second superior true molar is more or less sectorial, and the first true molar and even the fourth premolar in some of the genera, develop something of the same character. . But there is every gradation between the triangular *Didelphys*-like, and the sub-sectorial *Pterodon*-like forms of the superior molars, in this group of genera.

The glenoid cavity of the squamosal bone presents differences in the various genera of this sub-order. In *Arctocyonidæ* (fide De Blainville), *Oxyænidæ,* and *Mesonychidæ,* it is bounded by a transverse crest anteriorly, as well as by the postglenoid posteriorly, while in the *Leptictidæ* it is plane and open anteriorly. In *Amblyctonidæ* its condition is unknown. In existing *Carnivora* this character is not very constant as a family definition; it is best marked in the *Felidæ,* and least marked in the *Canidæ.* Nevertheless there is a group of genera allied to the *Oxyænidæ,* which are very marsupial in character, which have been called the *Leptictidæ,* and which differ so far as known from *Oxyæna* in the absence of the preglenoid crest. I suspect that these forms constitute a family by themselves, and for the present, until our knowledge of them is fuller, I define it by this character. The definitions of the families will then be as follows:

I. Ankle-joint plane transversely, or nearly so.

True molars above and below, tubercular; last superior not transverse.... *Arctocyonidæ.*

Superior true molars, tubercular; last superior premolar sectorial; first inferior molar "tubercular sectorial"........................ *Miacidæ.*

Superior last molar transverse; inferior molars tubercular-sectorial or with reduced anterior cusp; no preglenoid crest.................. *Leptictidæ.*

Last superior molar trenchant, transverse; first superior true molar sectorial; inferior true molars tubercular-sectorial; a preglenoid crest... *Oxyænidæ.*

* Proceedings Amer. Philos. Society, p. 76.

Last superior molar longitudinal ; inferior true molars without developed sectorial blade.......................................*Amblyctonidæ.*

II. Ankle-joint tongued and grooved, or trochlear.

Molar teeth in both jaws consisting of conic tubercles and heels ; none sectorial ; a preglenoid crest.......................................*Mesonychidæ.*

I now give the characters of the genera. All these are derived from examination of typical specimens. The opportunity of doing this I owe to the kindness of Messrs. Leidy, Gervais, Gaudry, Filhol, and Lemoine.

ARCTOCYONIDÆ.

Premolars, $\frac{4}{4}$; the first inferior one-rooted ; the last inferior well developed ; *Arctocyon* Blv.

Premolars below, 4, the first two-rooted, the last true molar much reduced ; (fide Lemoine).......................................*Hyodectes* Cope.

Premolars below, 3, first two-rooted ; true molars normal................ *Heteroborus* Cope.

MIACIDÆ.

Inferior tubercular molars two, premolars four...............*Miacis* Cope.

Inferior tubercular molars one, premolars four...........*Didymictis* Cope.

LEPTICTIDÆ.

I. Superior molars sub-equilateral, without cutting heel posteriorly.

a. Fourth inferior true molar like the true molars, with three anterior cusps.

β. Third superior premolar with internal cusp ; anterior cusp of inferior molars small, median.

Third premolar with one external and one internal cusps. *Mesodectes* Cope.

Third premolar with two external and one internal cusps....*Ictops* Leidy.

ββ. Third superior premolar without internal cusps ; anterior cusps of inferior molars present.

Cusps of superior molars marginal ; two superior incisors ; *Leptictis* Leidy.

Cusps of superior molars median in position ; anterior cusp of inferior molars well developed..............................*Peratherium* Aym.

βββ. Anterior cusps of inferior molars wanting.

Fourth inferior premolar like true molars.................*Diacodon* Cope.

aa. Fourth inferior premolar different from true molars in a simpler constitution.

Last inferior molar tubercular ; cusps of other true molars well developed; three inferior premolars...........................*Lipodectes* Cope.

Inferior true molars alike, with anterior inner cusps little developed ; three premolars (?).......................................*Triïsodon* Cope.

Inferior true molars alike, with cusps well developed ; four premolars.... *Deltatherium* Cope.

II. One or more superior molars, with the external heel produced into a blade.

a, Molars 4—3; three last inferior tubercular sectorial.

Premolars robust, conic.............................. *Quercitherium* Filh.
Premolars compressed; the fourth superior with a conic cusp and heel externally.. *Stypolophus* Cope.
Premolars compressed; fourth superior with a simple blade externally... *Proviverra* Rütim.

OXYÆNIDÆ.

I. Inferior molars without internal tubercles.

Molars, $\frac{4}{3}$ $\frac{3}{3}$; three sectorials in the lower jaw.............. *Pterodon* Blv.

II. Inferior molars with internal cusps.

a. Posterior heel of one or more superior molars elongate and trenchant.

Last inferior molar truly sectorial, without internal tubercle; second, tubercular-sectorial................................ *Protopsalis* Cope.
Molars, $\frac{4}{4}$ $\frac{3}{2}$; two last inferior molars tubercular-sectorial... *Oxyæna* Cope.

AMBLYCTONIDÆ.

Fourth inferior premolar with a broad heel supporting tubercles; an anterior and no internal tubercles................. *Amblyctonus* Cope.
Inferior molars with tubercular heel, an anterior and an internal tubercle. *Periptychus* Cope.
Dental formula below, 3, 1, 3, 3. Fourth inferior premolar with a cutting edge on the heel; both internal and anterior tubercles................ *Palæonyctis* Blv.

MESONYCHIDÆ.

a. Inferior molars seven;

Cones of inferior and superior molars simple........................ *Mesonyx*.
Cones of last two inferior molars with lateral cusps.................. *Dissacus*.

aa. Inferior molars ? six.

Internal lobes of penultimate superior molar v-shaped..... *Sarcothraustes*.

aa. Inferior molars five.

Inferior molars with strong anterior lobe......................... *Patriofelis*.*

MIACIS CANAVUS Cope.

Bulletin U. S. Geol. Survey, Terrs., 1881, p. 189. One mandible.

MIACIS BREVIROSTRIS Cope, loc. cit. p. 190.

Parts of four mandibles.

DIDYMICTIS DAWKINSIANUS Cope, l. c., p. 191.

Six mandibular rami more or less complete.

Individuals of the genus *Didymictis* are abundant in the Wasatch beds

* Of uncertain reference to this family.

of the Big-Horn, and a good many of them do not coincide well in characters with the species already described. I define them as follows, premising that with other parts of the skeleton some changes may be found to be necessary. The large *D. altidens* was not obtained by Mr. Wortman in the Big-Horn country.

I. Inferior tubercular molar oval in outline, with a heel.

Length true molars .010 ; last three premolars .0135 ; last molar narrow.. *D. dawkinsianus.*

Length true molars .016—.018 ; last three premolars .028—.030 ; last molar narrow.......................................*D. leptomylus.*

Length true molars .019—.020 ; last three premolars .036 ; last molar elongate...*D. protenus.*

Length true molars .025 ; last three premolars .035 ; last molar short..... *D. altidens.*

II. Inferior tubercular molar short, subquadrate in outline.

Length true molars .011 ; depth of ramus at sectorial .010................ *D. massetericus.*

Length true molars .018 ; depth of ramus at sectorial .017....*D. curtidens.*

Didymictis leptomylus Cope.

American Naturalist, 1880, p. 908.

The specimens which I refer at present to this species belong to two varieties, which may perhaps be specifically distinct; but this cannot be demonstrated at present. They differ in dimensions only. Thus the true molars of the type, which comes from the Big-Horn beds, measure M. .016 in length. Five specimens from the Big-Horn basin agree in having this dimension .018. The entire inferior molar series is only a little shorter than that of the smaller variety of the *D. protenus* from New Mexico (See my report to Capt. Wheeler, plate xxxix).

Didymictus protenus Cope.

Jaws more or less complete, of six individuals, are referable to this species. They agree closely in measurements and belong to the larger variety of the species figured on plate xxxix of the report to Capt. Wheeler.

Didymictis massetericus, sp. nov.

This species is intermediate in size between the *D. leptomylus* and the *D. dawkinsianus*, and is characterized by the peculiar form of its tubercular molar, and the deeply excavated masseteric fossa. It appears to have been a rare species, as only one mandibular ramus was found by Mr. Wortman. This is broken off in front of the fourth premolar, and supports the last true molar teeth.

The tubercular molar is subquadrate in form, and consists of three low tubercles in front, and a wide heel behind, which has an elevated posterior border. The tubercular-sectorial has a short and narrow heel. Its anterior cusps are not very acute, and the two internal are equal, and a good deal

shorter than the external. The fourth premolar is relatively shorter than in any other species of the genus, and the posterior marginal lobe is a mere thickening of the edge of the heel. There is a low anterior basal tubercle. The enamel is smooth.

The ramus is compressed and not deep. The angle is prominent, and is not inflected ; it does not extend so far posteriorly as the posterior border of the condyle. The inferior border of the masseteric fossa is an angular line, without abrupt excavation, but the face of the fossa descends rapidly. The anterior border of the fossa is abrupt and is formed by the usual subvertical ridge.

Measurements.	M.
Length between P-m. IV, and condyle inclusive	.0520
" of posterior three molars	.0170
" of tubercular-sectorial	.0070
Elevation of " "	.0070
Depth of ramus at sectorial	.0100

Didymictis curtidens, sp. nov.

As in the case of the *D. masseterícus* the present species is represented by a single fragmentary mandibular ramus. This supports a sectorial tooth of the size and form of that of the *D. protenus*, and is thus much larger than that of the species just named. This tooth is placed nearer to the base of the coronoid process than is seen in any other species, and only leaves space for a short tubercular tooth. This is lost from the specimen, but the alveolus shows pretty clearly its dimensions. The base of the fourth premolar remains, and it is evident that this tooth was like that of *D. protenus* in form and proportions. The base of the posterior marginal lobe is present. The ramus is deeper and larger than in the *D. massetericus.*

Measurements.	M.
Length of bases of last three molars	.0285
" " fourth premolar	.0120
" " of sectorial on base	.012
Width " in front	.008
Depth of ramus at sectorial	.017

Ictops bicuspis Cope. Bull. U. S. Geolog. Surv., Terrs. 1881, p. 192.

This mammal was founded on a skull from the Wind River region. It is now represented by a mandibular ramus. The form of the fourth premolar being unknown, its reference to this species is provisional only. It may be remotely allied to *Stypolophus*, but the anterior inner cusp of the molars is small and does not reach the inner side of the crown, and the anterior external cusp is but little larger than the second anterior inner. The two cusps last named stand opposite to each other, and their apices are only separated from each other by an open notch. They, with the first anterior inner (here median), form a transverse narrow triangle. The posterior part of the crown is rather large and, though lower than the anterior part,

is absolutely quite elevated above the alveolar border. Its summit presents a V externally, and there is a small posterior median angle. In the last true molar this angle is a little more prominent than in the others, and rises into a cusp. The external bases of the crowns are protuberant, but there are no cingula. Enamel smooth.

The ramus is rather compressed, and the masseteric fossa is well marked, and is bounded anteriorly by a prominent rib.

Measurements.

		M.
Length of true molars		.0100
Diameters M. III	anteroposterior	.0035
	vertical	.0035
	transverse	.0030
Diameters M. I	anteroposterior	.0035
	transverse	.0028
Depth of ramus at M. II		.0070

This species is smaller in all dimensions than *I. didelphoides*, and the crowns of the molar teeth are shorter and more elevated than in that species.

Deltatherium absarokæ Cope. American Naturalist, 1881, p. 669.

A small species, represented by an imperfect cranium and lower jaw with nearly complete dentition.

Stypolophus aculeatus Cope.

Several fragmentary mandibles nearly coincide in measurements with this species. The molars are .0240 in length, and the ramus is .0140 in depth. The only difference in the measurements is that the true molars measure .0250 in *S. aculeatus*. The latter is, however, a species of the Bridger epoch, so that further comparison will be necessary before identification is made.

Stypolophus whitiæ, sp. nov.

Stypolophus strenuus Cope. Bulletin U. S. Geol. Survey, vi, 192; not of Report Capt. Wheeler, vol. iv, pt. ii.

The greater part of the skeleton, with skull and dentition of this species, were brought from the Big-Horn by Mr. Wortman. A part of a mandible of a second individual was also found. The species is, however, primarily based on a specimen from the Wind river. This is represented by a right mandibular ramus which supports all the molar teeth, and displays the alveolus of the canine, and lacks all posterior to the coronoid process; also by a portion of the frontal bone, two vertebræ, fragments of scapula, humerus, ulna, radius, ilium, and tibia, and the greater part of both tarsi. They represent a species larger than the Virginian opossum, and intermediate between the *S. brevicalcaratus* and *S. strenuus* in proportions. It has not the rudimental heels of the molars of the former species, nor the robustness of the latter.

The inferior outline of the mandible is gently curved from the canine

to below the last molar. The anterior border of the masseteric fossa is well marked, but not the inferior border. The ramus is compressed and deep. The canines have stout roots and narrow curved crowns. The first premolar is separated by a short space from the canine and by a longer one from the second premolar. It has either a single compressed root or two roots confluent within the alveolus. The crown is truncated obliquely behind. The second premolar is two-rooted and the crown is elevated anteriorly and depressed posteriorly. The third premolar is more symmetrical, but the heel is produced. It is narrow and keeled medially. The fourth premolar is abruptly larger than the third. Its crown is simple, except a low tubercle at the anterior base and a short trenchant heel at the posterior base. Of the three tubercular-sectorials the first is the smaller. The heels of all three are rather narrowed and elongate. Their margin is raised all round, inclosing a basin; a notch in the external margin cuts its anterior part into a tubercle. The two internal tubercles are rather obtuse, and are considerably shorter than the external cusp.

Measurements.	M.
Length from canine to end of last molar	.060
" " " first true molar	.037
" " " second premolar	.015
" of base of fourth premolar	.009
Elevation of fourth premolar	.007
Length of base of second true molar	.007
" heel " " "	.006
Elevation of second true molar	.009
Depth of ramus at third premolar	.015
Length of superior canine	.028
" crown of superior canine with enamel	.012

A portion of the frontal bone shows weak anterior temporal ridges uniting early into a sagittal crest, which is low as far as preserved. The parietal bones overlap the frontal as far forwards as the temporal ridges. Anterior to the latter the front is concave in transverse section. Viewed from below, the spaces for the olfactory lobes are large and entirely anterior to those which received the anterior lobes of the hemispheres; each one is about as wide as long. In the small part of the cerebral chamber wall left, there is no indication of convolutions, which would be visible in a gyrencephalous brain; two air-chambers in front of each olfactory lobe.

The base of the transverse process of the atlas is perforated from behind to the middle of its inferior side; from the latter opening a foramen penetrates directly into the neural canal. A posterior dorsal vertebra has the centrum longer than wide and much depressed. Its inferior face is regularly convex in section. The proximal end of the scapula shows that its inner border is much thickened, and that the spine arises abruptly and near to the glenoid cavity. There appears to have been scarcely any coracoid; the surface adjoining it is, however, injured. The humerus lacks

the proximal portion and the inner half of the condyles with the epicondyles. The deltoid crest is not very prominent, so that the shaft is rather slender. The external distal marginal crest is thin, and is continued well up on the shaft. The external part of the condyle displays no intertrochlear ridge. Olecranar and coronoid fossæ well marked. The olecranon is robust and deep, and is truncate posteriorly and below. The head of the radius is a regular transverse stout oval.

A fragment of the ilium from near the acetabulum displays a prominent "anterior inferior spine." The best preserved tarsus includes calcaneum, astragalus, cuboid, and navicular bones. The tibial face of the astragalus is strongly convex antero-posteriorly and slightly concave transversely. The head is prolonged some distance beyond the distal extremity of the calcaneum, and presents a convex internal border and a concave external one. Its long axis is parallel to that of the tibial portion, but is not in the same axis, owing to its lateral position. The external face of the trochlear portion is vertical, and is interrupted by a deep fossa behind. The internal face is very oblique, and becomes the superior face of the head. The posterior face of the trochlea is grooved with a wide and shallow grove, which just reaches the superior face, terminating on the external side. The superior face is not grooved, but is shallowly concave in transverse section. The head is a transverse oval, and is convex ; it has a small facet for the cuboid on the outer side.

The heel of the calcaneum is large and expands distally, so as to be as wide as deep. The convex astragalar facet is very oblique to the long axis of the calcaneum ; the sustentaculum is rather small. Below the latter is a narrow tuberosity looking downwards and forwards. On the external side, close to the cuboid facet, is a depressed crest. The cuboid facet is as deep as wide. The cuboid bone is a little longer than wide proximally, and narrows distally. It has a narrow astragaline facet and a deep fossa below proximally. The hook inclosing the groove for the tendon of the flexor muscle is prominent. The navicular is rather small, and has three inferior facets, which diminish in size outwards. It has a strong posterior knob-like process, with a narrow neck.

When the tarsal bones are in position, and the tibia stands vertically on the astralagus, the cuboid bone is turned interiorly. This indicates that this species walked on the outer edge of the hinder foot.

Broken metapodial bones are slender and straight. The proximal end of a metacarpal does not display the interlocking lateral articulation seen in *Protopsalis*. Two phalanges are depressed in form.

Measurements.		M.
Diameters of a dorsal centrum	anteroposterior	.0145
	vertical	.0075
	transverse	.0115
Diameters of glenoid cavity scapula	anteroposterior	.0145
	transverse	.0090

Measurements.	M.
Depth of olecranon	.0110
Width of head of radius	.0110
" neck of ilium anteroposteriorly	.0120
Diameter of shaft of tibia at middle	.0085
Diameters of astragalus — anteroposterior	.0180
Diameters of astragalus — greatest	
Diameters of astragalus — transverse — of trochlea	.0140
Diameters of astragalus — transverse — of head	.0100
Length of head	.0070
" calcaneum	.0300
Width of calcaneum at sustentaculum	.0140
" cuboid facet	.0066
Length of cuboid	.0120
Diameters — anteroposterior — distal	.0070
Diameters — anteroposterior — proximal	.0075
Diameters — transverse proximal	.0098
Diameters of navicular — vertical	
Diameters of navicular — transverse — with tuberosity	.0100
Diameters of navicular — transverse — without tuberosity	0070
Diameters of navicular — anteroposterior	

As already remarked, it is probable that the semigrooved trochlea of the astragalus of this species is an indication that the genus *Prototomus* must be retained as distinct from *Stypolophus*, to which the present species probably truly belongs.

The specimen described, together with the mandibular ramus of another supporting the last two molar teeth, were found in the bad lands of Wind river, Wyoming, by J. L. Wortman. Dedicated to Frances Emily White M. D., of Philadelphia.

OXYÆNA FORCIPATA Cope.

Report Vert. Foss., New Mexico, 1874, p. 12. Report Capt. G. M. Wheeler, U. S. G. G., Expl. Surv. W. of 100th Mer. IV, ii, p. 105, 1877.

This formidable animal was abundant in Northern Wyoming, during the Wasatch epoch. At least ten individuals are represented in the collection. The following are the dimensions of the mandibles of the five best preserved.

	1	2	3	4	5
Length of dental series	.103	?	.100	.100	.107
" premolar "	.042	.045	.044	.051	.054
Depth of ramus at M. III	.042	.039	.037	.042	.047

The measurement .035 for the length of the premolars given in my report to Capt. Wheeler, loc. cit., refers to the anterior three teeth, which were originally supposed to be the only premolars.

The claws of this species are moderately compressed, and they terminate abruptly and obtusely. The extremity is deeply fissured, and each of the two apices is rugose.

MESONYX OSSIFRAGUS Cope, American Naturalist, 1881, p. 1018.

Pachyæna ossifraga Cope. Report Capt. Wheeler, U. S. G. G. Surv. W. of 100th Mer. IV, ii, p. 94, 1877.

A series of specimens of this species demonstrates the following points: (1) *Pachyæna* was founded on a superior molar of *Mesonyx*, and must be suppressed. (2) *Mesonyx navajovius* Cope must be separated as a distinct genus, since the apices of the crowns of the last two molars have two cusps. I have called this genus *Dissacus* (American Naturalist, Dec., 1881). (4) It results that there are three species of *Mesonyx*: *M. ossifragus* Cope, *M. lanius* Cope, and *M. obtusidens* Cope.

M. ossifragus was the largest Creodont of the Eocene, equaling the largest grizzly bear in the size of its skull. In a cranium with lower jaw and almost complete dentition, the length to the premaxillary border from the postglenoid crest is M. .365; the largest *Ursus horribilis* in my collection gives .270 for the same length. This specimen has the dental formula I. $\frac{3}{2}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$. The claws have the flattened form which I discovered in *M. lanius*, and the proximal phalanges have much the shape of those of a Perissodactyle. The astraglus has much the character of the animals of that order, and has the distal facets as I originally detected them in the *M. obtusidens*. The form of this bone is rather shorter and wider than in the latter species.

The inferior canine tooth of a large specimen has the following diameters at the base of the crown: anteroposterior .039; transverse .024.

AMBLYPODA.

PANTODONTA.

The explorations in the bad lands of the Big-Horn river yielded several species of this sub-order, all which I refer at present to the *Coryphodontidæ*. They, however, represent several genera, two of which have not been previously known. I have distinguished these (American Naturalist, Jan., 1882), in the characters of the superior molar teeth as follows:

I. Last superior molar with two interior cusps.

All the superior molars with a well marked external posterior V......... *Manteodon.*

II. Last superior molar with but one inner cusp or angle.

a. Last superior molar with posterior external cusp.

Anterior two molars with posterior external V.................. *Ectacodon.*

aa. Last superior molar without external posterior cusp.

† Anterior two molars with posterior external V.

Astralagus transverse, with internal hook.................. *Coryphodon.*

Astragalus subquadrate, without internal hook.............. *Bathmodon.*

††First superior molar only with posterior external V....... *Metalophodon.*

The type of *Manteodon* is the *M. subquadratus*, which was about the size of an ox. The characters of its superior molars are more like those of Perissodactyles than are those of the other *Coryphodontidæ*. The type of *Ectacodon* is the *E. cinctus*, a species of about the dimensions of the last named. Its last superior molar is parallelogrammic, and has a cingulum all around it except on the external side.

Manteodon subquadratus, gen. et sp. nov.

Char. gen. These have been already pointed out in the key above given. They are a little more like those of the superior molar teeth of such *Perissodactyla* as *Limnohyus* and near allies, than those seen in the typical *Coryphodon*. The posterior transverse crest of that genus is here represented by a complete V, but the anterior lobe of that crest which represents the anterior V of the Perissodactyle, is only a lobe, as in *Coryphodon*. The tooth in fact is much like the penultimate molar of the latter genus. The two internal cusps are unique in the family. The additional one is a growth of the inner extremity of the posterior cingulum, and is separated from the anterior inner cusp by a deep and wide notch. It is opposite to the posterior V, as the anterior inner cusp is opposite the anterior rudimental V. The premolar and incisor teeth are similar to those of *Coryphodon*. The skeleton is unknown.

Char. specif. These are learned from a series of teeth which were found together by Mr. Wortman free from admixture of others. They are not worn, excepting by moderate use of the animal when living.

The last superior molar is not of the oval form belonging to the species of *Coryphodon*, but is quadrate, with the internal side shorter and with rounded lateral angles. The first anterior cingulum, which represents the anterior basal cingulum of the *Lophiodontidæ*, is as elevated as in the species of *Coryphodon*. Externally it rises in a protuberance with sharp edge, which curves posteriorly and disappears on the external side of the crown. The inner extremity terminates abruptly, forming the anterior interior tubercle. The anterior external lobe is rather flat, and is not conical nor elevated above the anterior cingular lobe. It is not deeply separated from the latter, nor from the posterior V; its edge is rough. The posterior V projects well inwards, and is rather narrow. Its posterior border extends as far outwards as the point of junction of its anterior border with the anterior external lobe, and terminates in a slight elevation of its border. The base of the crown extends external to the base of the V, and forms a strong posterior external protuberance. This causes the outline of the external base to be concave. This side of the crown has several small protuberances and rugosities. The posterior basal cingulum extends as far externally as the posterior V, and terminates internally in the posterior internal cusp. The second or basal anterior cingulum is well developed. There are no external nor internal cingula. The surface of the enamel is strongly and closely rugose where not worn.

The posterior inferior molar exhibits a transverse posterior crest, without

any tubercle or ridge in the mouth of the posterior V-shaped valley. There is a strong posterior cingulum, amounting to a narrow heel. As in the case of the superior molar, the enamel where not worn is closely and strongly wrinkled. The first superior premolar is characterized by the very small development of its internal lobe, which is only a strong basal cingulum. The crown proper has a sub-triangular outline, and the external face is flat and not concave. No external cingulum; enamel wrinkled. An external incisor has a large transversely extended crown, without cingula. A low rib on the median line of the inner side. Enamel wrinkled. In this and in another incisor, the base of the crown is considerably expanded laterally.

Measurements.		M.
Diameters of crown M. III, sup.	anteroposterior	.035
	transverse	.041
	vertical	.020
Width of M. III inferior, posteriorly		.022
Diameters P-m. I sup.	anteroposterior	.018
	transverse	.014
Diameter base crown I, II		.024
Length crown I, II		.019
Width base crown I, III		.026

ECTACODON CINCTUS, gen. et sp. nov.

Char. gen. In *Ectacodon* the last superior molar has more of the elements of a posterior external V than in *Coryphodon*, but not so much as in *Manteodon*. The posterior transverse crest, it is true, has no oblique posterior ridge joining it, to form with it more or less of a V. But the external posterior angle of the crown supports a cusp, homologous with the vertical rib found at the basal or external angles of the Vs in *Palæosyops* and allied genera, and indicating the outlines a V which lacks its posterior side, in a manner not seen in *Coryphodon*. The penultimate and ante-penultimate superior molars are like those of the latter genus. Skeleton unknown. I have a single species of this genus.

Char. specif. Six superior molars of one skull represent this species. They belong to a large animal, one about the size of the *Manteodon subquadratus*. The last superior molar has a characteristic outline. It is not oval as in the species of *Coryphodon*, nor quadrate as in *Manteodon* sp., but sub-parallelogrammic. The transverse diameter exceeds the anteroposterior, and the anterior and posterior sides are parallel. The external outline is slightly oblique and slightly notched in the middle. The internal border is regularly rounded. The basal or second cingulum extends entirely round the tooth from the posterior external cusp, round the inner base to the anterior external base of the crown; being absent only from the external base. The first cingula both anterior and posterior are well developed as in the species of *Coryphodon*, and unite in the prominent internal angle. The posterior first cingulum joins the posterior basal cin-

gulum at the middle of its length. The anterior first cingulum extends to the anterior external part of the crown, and then turns downwards and posteriorly and terminates at the middle of the external base. The posterior crest is not transverse, but quite oblique, sloping at an angle of 45° with the axis of the jaw. The part of the crest which represents the posterior V is a good deal larger than the part representing the anterior V, and is closely joined with it. The latter is well separated from the anterior first cingular ridge and its anterior exterior elevated portion. The enamel of this tooth is finely wrinkled, and is more readily worn smooth than in the *Manteodon subquadratus.*

The penultimate superior molar has the posterior V well developed, and its posterior basal or external angle is marked by a tubercle homologous with that which is so prominent on the last molar. The anterior V is a conic tubercle closely joined with the posterior V, and well separated from the anterior first cingular lobe. The basal cingular are well developed, but do not meet on the inner base of the crown. The first or superior cingula meet as usual in an interior angle, but there is a contraction of the anterior crest just before reaching this angle. The first true molar is smaller than the second and has the same general structure. Here, however, the anterior first cingulum is more prominent near the internal angle than the posterior. The characters of the premolars do not differ from the corresponding ones of species of *Coryphodon.* The enamel is delicately wrinkled. The first superior premolar is not preserved.

Measurements.		M.
Diameters of crown of M. III	anteroposterior	.034
	transverse	.043
	vertical	.015
Diameters M. I	anteroposterior	.028
	transverse	.033
	vertical	.012
Diameters P-m. III	anteroposterior	.023
	transverse	.030

It is probable that this species was about the size of an ox.

CORYPHODON ANAX, sp. nov.

Mr. Wortman sends me a number of teeth of probably two individuals, which exceed in size those of any species of *Coryphodon* yet known, and differ in certain details of form from all of them. The specimens consist of incisors, premolars and molars of both jaws of one animal, and an inferior canine, which from its separate wrapping, I suppose to have been derived from a different locality.

The incisors and premolars have the form usual in species of the genus, differing only in their large size. The same may be said of the premolars. A well preserved superior true molar is probably the third. It has the form usual in the genus, but exhibits two peculiarities. The posterior transverse crest is divided more deeply than usual by a deep notch which

enters it from the transverse valley. The external portion is the shorter, and exhibits the peculiarity of being connected with external part of the anterior transverse crest. It is as closely connected with this crest, as it is with the internal portion of the posterior crest. The external connection does not exist in the other species of the genus, where the two crests are separated at their outer extremities by a deep valley. The posterior basal cingulum is obsolete, while the anterior is well developed. The enamel of this tooth where not worn, is wrinkled.

The posterior part of the last inferior molar is characteristic. The posterior transverse crest is short and very oblique, its inner extremity striking the posterior margin near the middle. Here it is elevated into a cusp, which rises above the surrounding parts in a characteristic manner. There is no ledge round its posterior base, but the border expands outwards at the base of the true crest. The additional inner marginal tubercle is low and compressed as in *C. lobatus.* A second inferior true molar is normal, with well developed anterior marginal ridge. The inferior canine mentioned is of large proportions, exceeding by one-half the dimensions of the inferior canine of *C. lobatus.* Its crown is curved outwards, and has a basal alate expansion of its internal ridge.

Measurements.		M.
Diameters of last superior molar	anteroposterior	.039
	transverse	.051
Diameters of second inferior true molar	anteroposterior	.039
	transverse	.028
Length of inferior canine		.160
" crown of "		.090
Diameters of base of crown of canine	vertical	.037
	transverse	.036

This species is nearest the *C. lobatus* in some respects. The short posterior crest of the last inferior molar with its cusp-like extremity, and the absence of posterior ledge on this tooth will readily distinguish it.

Bad lands of the Big-Horn river, Wyoming.

There are six individuals of this species in the collection which are mostly represented by fine specimens, which represent the entire dentition.

Eight other species of *Coryphodon* were obtained by the Big-Horn Expedition, and the material enables me to distinguish them better than heretofore. I present the following differential synopsis of their characters.

I. The last inferior molar with three posterior cusps, the internal sometimes represented by a ridge; or the posterior inferior molars with an accessory cusp or tubercle on the inner side between the crests (*Coryphodon*, Owen):

An internal tubercle; last upper molar with the anterior cross crest and anterior external crest closely connected; size largest.......... *C. anax.*

An internal conic cusp ; posterior crest oblique ; heel very small ; size medium.. .... *C. cuspidatus.*
An internal crest ; posterior crest oblique ; heel small ; size medium..... *C. obliquus.*
An internal tubercle ; posterior crest little oblique ; heel large ; size large. *C. lobatus.*

II. Posterior inferior molars with two posterior cusps ; without internal accessory tubercle :

a. Posterior inferior molars with small or no heel :

Large ; posterior superior molar oval, with distinct straight posterior crest ; inferior molars elongate ; symphysis mandibuli produced and narrowed ; premaxillary elongate........................ *C. latipes.*
Medium ; inferior molars nearly as wide as long ; premaxillary short..... *C. latidens.*

aa. Posterior inferior molars with prominent or wide heel :

Medium ; posterior superior molar with posterior angle, and angulate posterior crest ; inferior molars elongate ; symphysis mandibuli broad and short ; premaxillary elongate ; tusk trihedral.... *C. elephantopus.*
Smaller ; premaxillary bone short ; tusk trihedral............... *C. simus.*
Medium ; premaxillary elongate ; tusk compressed and grooved......... *C. molestus.*
Large ; last superior molar oval, with angulate posterior crest ; its anterior lobe connected with anterior cingular crest.............. *C. repandus.*

III. Last inferior molar with but one posterior cusp from which a curved crest extends round the posterior border of the crown.

Superior true molars narrow ; external incisors sharply angulate on external face...................................... *C. curvicristis.*

IV. Posterior inferior molar unknown.

Posterior superior molar oval ; posterior crest straight ; internal crest fissured (? normally) ; a complete internal cingulum... *C. marginatus.*

Coryphodon cuspidatus Cope.

This species was found in a single individual obtained in New Mexico ; a second one was discovered by Mr. Wortman in the Wind River basin, and a third has now been brought from the Big-Horn.

Coryphodon latipes Cope.

I refer seven individuals provisionally to this species. Three of these are represented only by superior teeth, etc., and in four the last inferior molar is preserved. Of the latter, three have an angle, sometimes almost a crest, descending from the posterior inner tubercle, as in *C. obliquus,* but the specimens are all of superior size to that species, some of them very much exceeding it. It is also possible that this ridge is not a constant character. This species has the dentition which I have referred to the *Bathmodon radians,* but no astragalus of the species occurs in the collection. It may be the *C. latipes,* of which the teeth have not yet been identified. I hope soon to be able to decide this question.

CORYPHODON SIMUS Cope.

A broken mandible and maxillary bone, with several teeth represent this small species in the Big-Horn collection.

CORYPHODON ELEPHANTOPUS Cope.

Portions of the dentition of both jaws, including the last molar teeth of two individuals, prove that this species inhabited Wyoming in the early Eocene period. One of the individuals, represented only by the last molars of both jaws, is a little smaller than the typical specimen of which an entire cranium is figured in Capt. Wheeler's report (4to, 1877, Pl. LI–III), while a second specimen, which includes the entire superior molar series, is a little larger than the same.

This species is characterized by the obliquity of the edge of the posterior crest of the posterior superior molar backwards away from a transverse line; and by the slope of the external side of this crest. In other words the inner half of the posterior crest nearly forms a V, like that of the penultimate molar. The posterior edge of the V is present, running outwards from the inner end of the posterior crest, which thus becomes the apex of the V. The *C. elephantopus* thus most nearly approaches the genus *Manteodon*, of all the species. To accommodate the obliquity of the crest the posterior outline of the last upper molar is strongly angulate, giving a sub-triangular outline. The heel of the last inferior molar is insignificant.

CORYPHODON REPANDUS, sp. nov.

This large species is known from the posterior portions of the dentition of both jaws, with an entire symphysis.

The last superior molars are intermediate in outline between the regular oval of the *C. radians*, and the sub-triangular form of the *C. elephantopus*. The peculiarities of the species are seen in the posterior crest. The two lobes of which this is composed, do not form a continuous line as in *C. latipes* and *C. simus*, but form an angle with each other as in *C. anax*. The anterior lobe is compressed, and its long axis is nearly that of the jaw; the second lobe leaves it at a right-angle, but curves backwards as it extends inwards, giving a concave exteroposterior border. There is no ridge descending outwards from the inner extremity of the crest, to form a V, as in *C. elephantopus*. But the posterior basal cingulum extends to the external side of the tooth, which is not the case in any other species known to me excepting the *C. marginatus*. The anterior cusp is closely joined to the external elevation of the anterior first cingulum as in *C. anax;* a character which separates it from all other species. A strong trace of a cingulum passes round the inner base of the crown. No external cingulum. The first true molar does not differ materially from that of other species. It is considerably smaller than the last. The apex of the premaxillary bone with the second incisor and alveolus of the first, is preserved. The bone is rather short. The crown of the incisor is regularly convex ex-

ternally, and is not expanded at the base. There is a strong internal cingulum.

A fragment of the lower jaw supports the last two molars. The internal angle of the last one, is unfortunately broken. The posterior crest is, however, perfectly transverse, which is not the case with the species with three posterior tubercles. The preserved part of the posterior border shows a distinct, rather narrow heel. The anterior Vs are well developed and there are no lateral cingula. The symphysis is flattened out by pressure. The inferior canine is large. It is sub-triangular at base and has an anterior basal angular projection.

Measurements.

		M.
Diameters of superior M. III	transverse	.046
	longitudinal	.037
Diameters of superior M. I	transverse	.036
	longitudinal	.032
Diameters crown I. 2	vertical	.018
	transverse	.018
Diameters inferior M. III	transverse	.028
	anteroposterior	.040
	vertical in front (restored)	.024
Length of symphysis		.107
Depth of ramus at M. III		.056

The superior molars of this species might readily be taken for an undersized individual of *C. anax,* but the last inferior molar is of a different type, and refers the species to a different section of the genus.

CORYPHODON CURVICRISTIS, sp. nov.

The fragments which represent this species belong to one individual. They include a considerable part of both mandibular rami with numerous molar teeth, and most of the inferior incisors loose. Also the second superior molar, some superior premolars, the canine, and three or four incisors, two of them in place in an incomplete premaxillary bone. None of the bones of the skeleton were obtained, so far as known.

The ramus of the mandible is both robust and deep. Its inferior border does not rise posteriorly so much as in some species, as *e. g., C. latidens,* and the angle is well below the horizontal line of the dental alveoli. The dental foramen is just about in this line. The inferior premolars and molars do not differ from those of several other species, but the last molar has several peculiarities. The external cusp is the only one of the posterior pair which is present. It gives origin to two crests, both of them curved. The posterior represents the usual posterior transverse crest, but is gently convex backwards, and turns forwards on the inner side of the crown, only terminating at the external base of the anterior cross crest. The other curved crest is low, although higher than in most species, and extends to the middle of the base of the anterior cross crest. There is a distinct heel which is elevated at the middle and disappears gradually at each end, not being abruptly incurved as in *C. anax.* The anterior part of this

tooth is as peculiar as the posterior. The external cusp gives origin to three crests, two of them the usual limbs of the anterior V ; while a third descends to the anterior border a little exterior to its middle. It encloses a deep groove with the anterior ridge of the anterior V. This arrangement is not seen in any other species.

The inferior canine is robust, and has its anterior angle prominent, but not alate. The crowns of the inferior incisors are regularly convex exteriorly, and have no cingula. They are regularly graded in dimensions.

The superior molar preserved is probably the penultimate. Its anterior portion is broken. The posterior external V is narrower than usual for a second molar, and resembles somewhat that of the last superior molar of the *Manteodon subquadratus*. A slight contact face on the posterior cingulum shows that this tooth is not the last molar. The said cingulum extends to the external base of the V; in rising to the internal cusp it forms a sigmoid curve. The cingulum below this, on the inner base of the crown, is rudimental. The superior canine has a long and robust crown, with a triangular section to the apex. The posterior face is a little wider than the other two, which are equal. The anterior is slightly concave in cross-section, and the posterior slightly convex transversely, although concave longitudinally. There is a weak ridge nearly parallel to and near the postero-external angle, and traces of others on the postero-external face of the crown in front of this one. The antero-internal angle is swollen at the base.

The superior incisors present characteristic features. The ridge of the external face, which is weakly developed in some of the species, and is wanting in others, is here represented by a strong longitudinal angle, which extends from the base of the crown to its apex, dividing the external face into two distinct planes. This character is most marked on the external incisor, where the planes are sub-equal, and concave. On the second the anterior plane is smaller, and on the first it is a good deal smaller. These incisors have a weak internal cingulum, but no external one.

Measurements.		M.
Length of ramus from P-M. IV inclusive		.257
" inferior true molars		.098
Diameters of M. I infer.	anteroposterior	.0275
	transverse	.020
Diameters of M. III infer.	anteroposterior	.036
	transverse	.029
Depth of ramus at M. III		.075
Diameters of M. II super.	anteroposterior	.0315
	transverse	.039
Diameters of crown of superior canine	longitudinal	.094
	anteroposterior	.022
	transverse	.034
Diameters of crown of I. iii	vertical	.022
	transverse	.024

The numerous characteristic marks, show that this species is one of the most distinct of the genus. It is also one of the largest, being second only to the *C. anax.*

CORYPHODON MARGINATUS, sp. nov.

This is one of the smaller species, having nearly the dimensions of the *C. molestus.* It is only represented by the superior canine, first inferior premolar, and last superior molar of one individual found together by Mr. Wortman. Their size, mineral condition and degree of wear, render it probable that all belong to one individual.

The superior molar is of the oval type, without posterior shoulder. The posterior crest is therefore straight, and parallel with the anterior crest. Its inner extremity does not display the least tendency to form a V, as is seen in *C. elephantopus.* Its exterior extremity is widely separated from the external prominence of the anterior crest (cingulum). The latter displays, at its inner extremity, the peculiarity of a deep fissure of the anterior side, which nearly divides the crest, and partially isolates the internal tubercle. Adjacent to the fissure its crest is tuberculate. The posterior upper cingulum descends from the inner cusp to the basal cingulum. The basal cingulum is well developed on the anterior and interior sides of the crown, and on the posterior as far as the base of the inner cusp of the posterior crest, where it gradually fades out. Enamel wrinkled.

The superior canine is remarkable for its small size. The posterior face is a little the widest, and its bounding edges are sharp, but not expanded. There are no prominent ridges of the enamel. The anterior face is moderately wide. The first inferior premolar presents no peculiarities.

Measurements.

		M.
Diameters of M. III superior	anteroposterior	.028
	transverse	.038
	vertical	.019
Diameters of P-m. I inferior	anteroposterior	.015
	transverse	.009
Diameters of C. superior	anteroposterior	.014
	transverse posterior	.018

The superior molar is but little worn, and shows that the animal was just adult. The canine is more worn than the molar.

There are several characters which mark this species as distinct from those previously known. It is the only member of the genus which has a complete internal cingulum. The fissure of the anterior crest, if normal, is peculiar to this species. The superior canine is disproportionately small.

Besides the *Coryphodons* already mentioned, a number of more or less complete skeletons were obtained, some of which can be identified by comparison with those which are accompanied by teeth, and which are enumerated in the preceding pages.

METALOPHODON TESTIS, sp. nov.

The genus *Metalophodon* was described by me in 1872.* Since that time it has remained without further illustration of importance, as no good specimens of it have been obtained by any of my expeditions up to the present year. Thy material now at hand consists of the entire superior molar series of the right side, and the superior molars of the left side, in beautiful preservation. These display the characters on which the genus was proposed, *i. e.*, the conversion of the posterior external V of the second true molar into a transverse crest similar to that of the last true molar. It follows that the first true molar is the only one which exhibits this V. It also follows that in this genus the peculiarities of the dentition of *Coryphodontidæ* are carried further than in *Coryphodon,* where two molars display the V, and one the crest; or than in *Manteodon,* where all three have a V, and none the crest. The genera then stand in the order of evolution, *Manteodon, Coryphodon, Metalophodon.*

Char. specif.—The first superior premolar has lost its crown. The other premolars do not display any marked peculiarities. The internal cusps are well developed, and are most prominent posterior to the line of the apex of the exterior crest. They connect with the posterior cingulum by a broad ledge, but do not connect with the anterior cingulum. The two cingula nearly connect round the inner base of the crown on the third premolar.

The first true molar is well worn. The base of the posterior external V can be seen, and the anterior and posterior cingula. There is no internal cingulum. The second true molar is the largest of the teeth. It is subtriangular in outline, its external side forming with the posterior, a right angle. Its general character is much like that of the Coryphodontes, but it presents the remarkable exception which constitutes the character of the genus *Metalophodon.* The posterior crest does not include a V, but is straight, and consists of the same elements as the posterior crest of the third true molars, but differently proportioned. The part representing the anterior V is a cone, much shorter than the part corresponding to the posterior V. As there is a postero-exterior angle of the crown there is an oblique surface rising to this part of the crest, which represents the external face of the V. There is also a small tubercle at the angle, where a similar one is found in the corresponding tooth of *Ectacodon cinctus.* Altogether this tooth is like the posterior molar of *Coryphodon elephantopus,* with a more prominent postero-external angle added. The anterior and posterior basal cingula are well developed, the latter being strong interiorly to the point where it sends a branch upwards to the internal cusp. There is no internal cingulum.

The last superior molar is a transverse oval, more regular than usual in the species of *Coryphodon,* since the diameters of the internal and external portions are about equal. The characters of the posterior crest differ from

* Proceedings American Philos. Soc., 1872, p. 542.

those seen in the genus named in that the internal portion is much smaller than the external, having a small conic apex, distinct from that of the exterior portion. Its postero-external face is nearly vertical, and it diverges a little posterior to parallel with the anterior crest. The latter (the first cingulum) is elevated, and is widely separated externally from the posterior crest, to whose base it descends on the external extremity of the crown. The basal cingulum is present all round the the crown except at the base of the posterior crest, and externally. It is narrow on the inner extremity of the crown. It sends upwards a strong branch to the apex of the internal cusp. The enamel of all the molars is strongly wrinkled, but is worn smooth wherever rubbed.

Measurements.		M.
Length of superior molar series		.179
" premolar series		.085
Diameters P-m. II	anteroposterior	.019
	transverse	.025
Diameters M. I	anteroposterior	.029
	transverse	.032
Diameters M. II	anteroposterior	.036
	transverse	.042
Diameters M. III	anteroposterior	.0285
	transverse	.041
	vertical	.015

The *Metalophodon testis* differs from the *M. armatus*, in the more triangular form of its penultimate superior molar. Its form is quite different from that of the last molar, while in *M. armatus*, the two teeth resemble each other closely. The species are of about the same size.

The individual from which the above description is taken is rather aged.

Dinocerata.

Bathyopsis fissidens Cope.

Bulletin U. S. Geolog. Survey, Terrs., Feb. 1881, 194.

A considerable part of the dentition of the mandible of this species was found in the Big-Horn bad lands. This includes an incisor tooth, which is quite characteristic, and renders it probable that the anterior parts of the jaws differ considerably from those of other *Uintatheriidæ*. The root is sub-round. The crown resembles a good deal that of the species of *Coryphodontidæ*. It is higher than wide and has a subacute apex. One edge of the crown is convex, and the other concave. The external face is concave in both directions, and has no ridges nor cingulum. The inner face is concave longitudinally and convex transversely. The convexity is median and has a longitudinal concavity on each side of it. No internal cingulum except a trace at the base of the concave edge. The edges are obtuse even when unworn, and the enamel is obsoletely rugulose.

Measurements of incisor.		M.
Diameters of crown	anteroposterior	.012
	transverse	.020
	vertical	.020
Diameters of root	anteroposterior	.012
	transverse	.014

This incisor is very different from the kind seen in *Loxolophodon.* Mr. Osborne has shown that genus to have these teeth with compressed two-lobed crowns, a type unknown elsewhere among *Mammalia.**

PERISSODACTYLA.

In a paper on the "homologies and origin of the molar teeth of the Mammalia Educabilia," published in March, 1874,† I ventured the generalization that the primitive types of the Ungulata would be discovered to be characterized by the possession of five-toed plantigrade feet, and tubercular teeth. No Perissodactyle or Artiodactyle mammal was known at that time to possess such feet, nor was any Perissodactyle known to possess tubercular teeth. Shortly after advancing the above hypothesis, I discovered the foot structure of *Coryphodon*, which is five-toed and plantigrade, but the teeth are not of the tubercular type. For this and allied genera, I defined a new order, the *Amblypoda:* and I have published the confident anticipation that genera would be discovered which should possess tubercular (bunodont) teeth. This prediction has not yet been realized. I now, however, record a discovery, which goes far towards satisfying the generalization first mentioned, and indicates that the realization of the prophecy respecting the *Amblypoda*, is only a question of time.

In 1873,‖ I described from teeth alone, a genus under the name of *Phenacodus*, and although a good many specimens of the dentition have come into my possession since that date, I have never been able to assign the genus its true position in the mammalian class. The teeth resemble those of suilline Ungulates, but I have never had sufficient evidence to permit its reference to that group. Allied genera recently discovered by me, have been stated to have a hog-like dentition, but that their position could not be determined until the structure of the feet shall have been ascertained.§

In his recent explorations in the Wasatch Eocene of Wyoming, Mr. J. L. Wortman was fortunate enough to discover nearly entire skeletons of *Phenacodus primævus*, and *P. vortmani*, which present all the characters essential to a full determination of the place of *Phenacodus* in the system. The unexpected result is, that this genus must be referred to the order *Perissodactyla*, and that with its allies, it must form a special division of that order corresponding in the tubercular characters of its teeth with the

* A Memoir on *Loxolophodon* and *Uintatherium*. By H. Osborne.

† Journal of the Academy of Natural Sciences, Philadelphia.

‖ Palæontological Bulletin No. 17, Oct., 1873, p. 3; also, Report G. M. Wheeler, U. S. Engineers Expl. W. 100 Mer., iv, p. 174—1877.

§ Proceedings Amer. Philos. Society, 1881, p. 495.

bunodont or suilline division of the *Artiodactyla.* In this character, however, there is a closer gradation than in the case of the *Artiodactyla,* and it would scarcely be necessary to create such a group on that character alone. But the genus differs further from the *Perissodactyla* and approaches the *Proboscidia,* in the fact that the astragalus articulates with the navicular only, and by a universally convex surface, as in the Carnivora.

The astragalus resembles that of the latter order very closely, and differs from that of *Hyracotherium* and the nearest forms among the *Perissodactyla. Phenacodus* has moreover five well developed toes on all the feet, and was probably not entirely plantigrade. The cast of the brain case shows that the cerebral hemispheres were quite small and nearly smooth, and that the very large cerebellum and olfactory lobes were entirely uncovered by them. The bones of the two carpal rows alternate with each other, and there is a large third trochanter of the femur. The cervical vertebræ are opisthocœlous.

This group is then the ancestral type of the known *Perissodactyla,* that is of the horses, tapirs and rhinoceroses, and of the numerous extinc forms. Its systematic position may be schematically represented as follows:

Order Perissodactyla; ungulate; digits of unequal lengths; carpal bones alternating; a postglenoid process. Astragalus with proximal trochlea, and without distal double ginglymus.

Suborder *Diplarthra;* astragalus distally plane or concave in one direction, and uniting with both navicular and cuboid bones; a third trochanter of the femur. The known families belong here.

Suborder *Condylarthra;* astragalus convex in all directions distally, only uniting with navicular bone; a third trochanter of femur.

Family *Phenacodontidæ.* Molar teeth tubercular; the premolar teeth different from the molars; five digits on all the feet.

Genera; *Phenacodus* Cope, and very probably *Catathlæus, Anacodon* and *Protogonia* Cope, and perhaps also *Anisonchus* Cope. These genera include fifteen species, all from the lower Eocene beds. I gave a synopsis of their differential dental characters in the Proceedings of the Philosophical Society, 1881, p. 487, where I included also the genus *Mioclænus.* I omit the latter from the family at present, as I believe it to be Artiodactyle.

Phenacodus primævus Cope.

Parts of a dozen individuals of this species were obtained, and one almost entire skeleton in a block of soft sandstone. This includes nearly all parts of the four extremities, as well as the skull, from which but small portions are wanting.

Species of this genus, so far as determinable from the dentition, are numerously represented in Mr. Wortman's collection. About fifty individuals are referable to eight species. These present a great range in size, and some diversities of structure. They may be distinguished as follows:

I. Last inferior molar with oval outline; heel small; anterior inner cusp simple.

Size medium; length of true molars .025; depth of ramus at M. II, .018. *P. apternus.*

II. Last inferior molar wedge-shaped, with heel prominent; anterior inner cusp simple.

Large; true molars .041; P-m. IV .014; depth of ramus at M. II, .027. *P. primævus.*

Medium; true molars .027; depth at M. II .017; last molar smaller...... *P. vortmani.*

Smaller; true molars .022; depth at M. II .013; last molar elongate;.. *P. macropternus.*

Smaller; last four molars .027; P-m. IV .007; depth at M. II .013; last molar with short heel............................*P. brachypternus.*

Smallest; true molars .017; depth at M. II .012; heel long; cusps elevated..*P. zuniensis.*

III. Last inferior molar wedge-shaped, with prominent heel; anterior inner cusp double;

Least; last inferior molar .006; heel narrow; true molars (superior) .016. *P. laticuneus.*

Two other species have been described, the *P. sulcatus*, and *P. omnivorus* Cope. The former I suspect belongs to another genus. I am not now sure of the distinctness of the latter from *P. primævus.*

Phenacodus hemiconus, sp. nov.

Represented by the posterior two superior molars of an individual intermediate in size between the *P. primævus* and *P. puercensis.* The posterior molar is peculiar in the very rudimental character of the posterior internal lobe, which is reduced to a mere wart on the cingulum. The posterior external tubercle is also rudimental, not exceeding the posterior inner in dimensions. The anterior tubercles, including the intermediate, are well developed, the internal exceeding the external. The cingulum is wide and crenate, and is only wanting on the external base of the crown. The penultimate molar does not differ so much from that of *P. primævus*, but the two internal cones are not so deeply separated at their base. The tubercles are all but little worn, and are conical in form, the external flattened on the external faces. Enamel wrinkled.

Measurements.		M.
Diameters of M. II	anteroposterior	.009
	transverse	.012
Diameters of M. III	anteroposterior	.010
	transverse	.013

The size of this species precludes the possibility of its identity with any of the other species described here.

Phenacodus wortmani Cope. Bulletin U. S. Geol. Surv. Terrs. vi, 1881, p. 199. *Hyracotherium vortmani*, American Naturalist, 1880, p. 747.

Phenacodus puercensis Cope. Proceeds. Amer. Philos. Soc. 1881, p. 492.

An abundant species, represented by twelve mandibular rami in the collection, and by a nearly entire skeleton with perfect skull.

PHENACODUS APTERNUS, sp. nov.

Three rami, each of which supports the true molar teeth, indicate this species. The oval form of the posterior molar is due to the shortness of the heel, and the large size of the internal median tubercle, which projects inwards, giving a convex outline to the interior side of the crown. The external tubercles of all the true molars wear into crescents ; and the anterior inner is more robust than the posterior inner.

PHENACODUS MACROPTERNUS, sp. nov.

This species is apparently rare, being represented by only one mandibular ramus, which supports the posterior three molars, and a possible second ramus with molars iv and v. The first and second true molars are much like those of *P. vortmani*, but the third is relatively larger, and has an especially elongate heel. In *P. vortmani* the last molar is constricted, and narrower than the penultimate. In *P. macropternus* there is a weak external, and no internal cingulum. The tubercles of the last two molars are quite regularly conical, while the external pair of the first molar, wear into crescents. Smaller than the *P. vortmani*.

PHENACODUS BRACHYPTERNUS, sp. nov.

Three mandibular rami are the only specimens of this species found by Mr. Wortman in the Big-Horn region. They all display the fourth premolar, which has the characters of this genus, as distinguished from *Mioclænus*. The species is materially smaller than the *P. vortmani*, and its last inferior molar is intermediate between those of the latter and the *P. apternus*, in form. Both the internal and external intermediate tubercles are very full, and give the tooth posterior width. The posterior or fifth tubercle is large, and gives the posterior outline of the crown a trifoliate form. The posterior median tubercles of the M. II and I, are well marked. The molars gradually increase in size forwards, and the fourth premolar is longer than any of them, and rather narrow. The heel of the P-m. III is short and wide. On the true molars a weak external cingulum. Enamel slightly wrinkled.

PHENACODUS ZUNIENSIS Cope. Proceeds. Amer. Philosoph. Society, 1881, p. 462.

Mr. Wortman obtained eleven mandibular rami of this species, in only one of which are the premolars preserved. Excepting the *P. laticuneus*, this is the smallest species of the genus. The molars have much the appearance of those of the Mesodont genus *Hyopsodus*, but may be distinguished by the size of the posterior median tubercle. The second true molar is the widest tooth, and the last molar is rather elongate, and its cusps are not exactly opposite to each other. The cusps of the molars

are more elevated than in the other species, and those of the external side all have a distinctly crescentic section. The anterior inner cusp is narrow and simple. There is no cingulum of any kind.

This species was originally described from New Mexican specimens.

PHENACODUS LATICUNEUS, sp. nov.

This is the least species, and is represented by six superior molars and the last inferior molar in a fragment of the lower jaw. The latter tooth exhibits peculiar characters already mentioned. The superior molars differ from those known to belong to the *P. primævus* and *P. puercensis* in having a vertical fissure of the inner side which separates the bases of the two internal tubercles. This gives them some resemblance to the superior molars of the species of *Anisonchus*, but the important difference remains in the separation of the anterior inner tubercle from the intermediate tubercles. The three are confluent into a V in the genus last mentioned.

The external cusps of the superior molars are rather acute, and lenticular in section, their external sides forming a convex rib. There is no rib between the external sides. There is a strong anterior cingulum, which terminates externally in a low angular cusp. There is no cingulum on any other part of the crown. The second, third and fourth premolars have two external cusps, and much resemble the corresponding teeth in *Hyracotherium*. The second is longer than wide, and has an internal ledge; the third is as wide as long and has a wide internal ledge; the fourth is wider than long and has an internal, and two intermediate cusps, and an anterior and posterior cingulum. They all have a weak external cingulum, of which a trace exists in the true molars.

The last inferior molar has a double anterior inner cusp as in some *Mesodonta*, and the external anterior cusp is robust. All the cusps are conical and with round section, and their bases are close together. The outline of the base of the crown is almost an isosceles triangle with rather wide base in front.

Measurements.		M.
Length of last six superior molars		.0350
" true molars		.0160
Diameters of M. II	anteroposterior	.0055
	transverse	.0080
Long diameter base of P-m. II		.0050
Diameters P-m. III	anteroposterior	.0060
	transverse	.0060

ANACODON URSIDENS, gen. et sp. nov.

Char. gen. Known only from mandibles supporting molar teeth. Probably family *Phenacodontidæ*. Last inferior molar with heel. Crowns of molars without distinct cusps, but with a superior surface consisting of two low transverse ridges separated by a shallow valley. Unworn grinding surface with shallow wrinkles. Perhaps only three premolars.

Char. specif. Broken mandibular rami of two individuals constitute the basis of my knowledge of this species. It is of the size of the *Phenacodus primævus.* The last inferior molar is wedge-shaped with the very obtuse apex posterior. It displays two slight transverse elevations anteriorly which represent the usual cusps. Grinding surface generally nearly flat. The posterior half of the crown of the penultimate molar is flat, and is separated from the anterior half by a transverse groove. Its surface is marked by shallow branching grooves.

The molar preceding this one in the broken specimen is probably the first. It is possible from its slightly worn condition that it is the fourth premolar, but the form is that of a true molar. The surface of the crown is marked by shallow grooves not very closely placed. The three premolar teeth in advance of this tooth are broken off. Their bases are narrow. There are no basal cingula on the molars.

Measurements.		M.
Length of posterior true molars		.033
Diameters of M. III	anteroposterior	.015
	transverse	.010
Diameters of M. ? I	anteroposterior	.015
	transverse	.011
Depth of ramus at M. II		.030

The characters of the teeth of this species are something like that of some of the *Palæochœri* of the Miocene, and resemble more those seen in some of the bears.

OLIGOTOMUS OSBORNIANUS, sp. nov.

Char. gen. Dental formula; I. ?, C. ?, P-m. ? $\frac{4}{4}$; M. $\frac{3}{3}$. External faces of external lobes of superior molars separated by a ridge; anterior external cusp of cingulum little developed. Premolars of superior series different from true molars, with only one internal lobe. Fourth inferior premolar similar to the true molars. Cusps of inferior molars connected by diagonal ridges forming Vs. A diastema in front of the second premolar.

This genus is a good deal like *Lambdotherium,* so far as known. Its superior molars are much like those of *Aeoëssus,* and their intermediate and internal tubercles are those of *Hyracotherium.*

The two or three species known to me are of small size.

Char. spec. The true molars of both maxillary bones, with the fourth premolar of one side are preserved more or less perfectly, with four inferior molars on two fragments of the lower jaw.

The external tubercles of the superior molars are nearly erect, and have a lenticular section. The rib which separates their external faces is prominent, and terminates in a free apex. The base of each face is marked by a strong cingulum, but the posterior one is very short. There is a strong anterior basal cingulum, but no posterior or internal one. The anterior inner tubercle is larger than the posterior. The intermediate tubercles are

sub-round, and are anterior to the transverse line of the interior ones. They do not join the latter excepting after very considerable wear. The external anterior cingular cusp is rather more prominent on the first than on the second true molar. The fourth superior premolar has a well marked external anterior cingular cusp, which is, however, low; and there is no ridge dividing the external faces of the external cusps. The single inner cusp is connected with the two external by two ridges, which diverge as they extend outwards. The anterior supports a tubercle close within the anterior external. There are strong anterior and posterior basal cingula and weak external and internal ones.

The third inferior premolar has a compressed ridge on the heel. The fourth premolar is like a true molar, with the anterior inner cusp well developed and elevated, and connected with the anterior and posterior external by oblique ridges. The inner posterior cusp is less conic in form than in the true molars, and the entire crown is somewhat contracted anteriorly. The true molars are characterized by the presence of a small median tubercle on the posterior border. There is a low external basal cingulum, which is wanting opposite the posterior cusp. Enamel generally smooth.

Measurements.		M.
Length of superior true molar series		.0210
Diameters of superior M. II	anteroposterior	.0080
	transverse	.0097
Diameters of P-m. IV	anteroposterior	.0085
	transverse	.0085
Length from inferior P-m. III to M. II inclusive		.0290
Diameters of P-m. IV	anteroposterior	.0080
	transverse	.0050
Diameters of inferior M. II	anteroposterior	.0075
	transverse	.0060
Depth of ramus between P-m. III and P-m. IV		.0150

As compared with the *O. cinctus*,* this species differs in its superior dimensions. The anterior inner cusp of the inferior molars is probably single, though the slightly worn condition of those teeth renders this point a little uncertain. In *O. cinctus* some of them at least are double.

This species was, to judge from the size of its teeth, about the size of a red-fox. The specimens of it above described were found by Mr. J. L. Wortman in the bad lands of the Big-Horn river, Wyoming. It is dedicated to my friend, Henry L. Osborne, of Princeton College, New Jersey.

SYSTEMODON TAPIRINUS Cope. American Naturalist, 1881, p. 1018.

Hyracotherium tapirinum Cope. Systematic Catalogue of the Eocene Vertebrata of New Mexico, 1875, p. 20. Report U. S. Geol. Surv. W. of 100th mer. Capt. G. M. Wheeler, iv. ii. p. 263. Pl. lxvi. figs. 12–16.

This species was abundant in Wyoming during the Wasatch epoch, jaws and teeth of more than twenty individuals having been brought by

* Annual Rept. U. S. Geol. Survey Terrs. 1872, p. 607.

Mr. Wortman from the Big-Horn. From these I learn that the dental system is different from that characterizing the species of *Hyracotherium.* There is no diastema posterior to the superior canine, while in the latter genus there are two. Anterior to the canine there is a considerable one in the *Hyracotherium.* This part is not preserved in any of the specimens of *S. tapirinum.* The characters mentioned have induced me to separate the latter as type of a distinct genus, *Systemodon.* An examination of the figures and descriptions given by Dr. Lemoine of his *Pachynolophus gaudryi* found by him in the neighborhood of Reims, shows that it belongs to the genus *Hyracotherium.* It is therefore distinct from either of the species of *Systemodon,* and is to be compared with the *H. craspedotum* of the Wind River country, with which it agrees in size.

SYSTEMODON SEMIHIANS, sp. nov.

This species was also abundant in the Big-Horn region, jaws and teeth of sixteen individuals having been obtained. Its dimensions are a little smaller than those of the *S. tapirinus,* especially as to the premolar teeth. There is also a short postcanine diastema, which is not seen in the *S. tapirinus.*

The proportions of the maxillary series are represented by a left maxillary and premaxillary bone, with all the teeth in place, but the crowns lost from the first premolar anteriorly. The crowns of the true molars are somewhat worn, so I confine the description of these to the premolars. The third and fourth have considerable transverse extent, the latter being wider than long. The second has scarcely any internal tubercle, but only a low postero-internal heel. The internal tubercle of this tooth is large in *S. tapirinus.* The crown has two cusps, the posterior lower. The last two premolars have two external cusps close together. They have also an anterior external cingular lobe, as in the true molars. There is a posterior external basal lobe in the third premolar, but none or a rudiment on the fourth. No internal cingulum on the premolars. The superior true molars, although worn, show a prominent anterior external basal lobe, and no complete internal cingulum The base of the crown of the first premolar is narrow antero-posteriorly, and it has two roots as in *S. tapirinus.* It is in close contact with the second premolar, and is separated from the base of the canine by a space a little less than its own anteroposterior diameter, and less than the diameter of the canine. The base of the crown of the latter shows that it is not a large tooth, and has a wide lenticular section. The base of the external incisor is rather large, and is compressed.

Measurements of superior teeth.		M.
Total length of superior series		.0720
" " " molar "		.0310
" " " premolar "		.0250
Diameters base of canine	anteroposterior	.0055
	transverse	.0040

Measurements of superior teeth.

		M.
Length of base of P-m. I		.0040
Diameters P-m. III	anteroposterior	.0070
	transverse	.0078
Diameters P-m. IV	anteroposterior	.0070
	transverse	.0090
Diameters M. III	anteroposterior	.0100
	transverse	.0125

Some superior molars in better condition than those last described, exhibit the following characters. The intermediate tubercles are fused with the internal, forming a continuous cross crest, but their apices are distinguishable. The external cusps are subconical and are well separated. The anterior and posterior cingula are strong, the external is weaker, and it is wanting from the posterior part of the internal base of the crown.

A portion of a mandibular ramus, supporting six molars, presents the following characters. The teeth are a little smaller than those of *S. tapirinus*, the reduction being especially visible in the premolars. The cones of the crowns are more distinctly separated by notches than in that species; and are quite distinctly conic. The anterior ledge of the true molars is distinct, and there is a median posterior tubercle of the first two, which is represented by the wide crenate-edged heel of the third true molar. The anterior-internal cusps of the last two molars is double or bilobed ; that of the first is last. The anterior cones of the fourth premolar are subequal, and the posterior external cone is elevated. There is a trace of the posterior internal. There is also an anterior ledge. The heel of the third premolar rises to a median blade and posterior cusp. The anterior cusp is elevated and compressed, and supports a small internal lateral cusp. The base of the crown of the third premolar is elongate. All the teeth are rather compressed, and there is only a trace of an external cingulum.

The ramus is compressed and moderately deep. The dental foramen is large, and its superior border is on a level with the posterior base of the crown of the third true molar. Its inferior base is in line with the base of the crown of the second true molar.

Measurements of mandible.

		M.
Length of last six molars		.0530
" true molars		.0310
Diameters third premolar	anteroposterior	.0065
	transverse	.0040
	vertical	.0052
Diameters second true molar	anteroposterior	.0092
	transverse	.0060
	vertical	.0062
Diameters third true molars	anteroposterior	.0120
	transverse	.0060
Depth of ramus at P-m. III		.0170
Depth of ramus at front of M. III		.0220

The nearest ally of this species outside of the genus *Systemodon* is probably the *Hyracotherium craspedotum* Cope. This species was brought from the Wind River bad lands, and does not occur in the Big-Horn collection. It is about the size of the *S. semihians*, but is a true *Hyracotherium*, with a diastema behind the first premolar. The strong cingulum which characterizes it is not found in the *S. semihians*, and the inferior molars are wider and more robust.

HYRACOTHERIUM CRASPEDOTUM Cope.

Bulletin U. S. Geol. Survey, Terrs., 1881, p. 199. American Naturalist, 1880, 747.

The dentition of this species is in its dimensions and proportions intermediate between the two species of *Systemodon*. Its three premolars equal four of those of the *S. semihians*, while the molars of the two species are about equal.

A specimen having the proportions of the *H. craspedotum* was found by Mr. Wortman on the Big-Horn, but unfortunately it does not exhibit the characteristic cingula of the two dental sories. The second superior premolar, like that of *Systemodon semihians* has no internal tubercle. It is not certain whether there is any diastema posterior to the first superior premolar. I therefore cannot yet ascertain whether this specimen represents an undescribed species of *Systemodon* or *Hyracotherium*, or a strong variety of the *H. craspedotum*. The accompanying inferior true molars are intermediate in size between those of the latter species and the *H. vasacciense*.

HYRACOTHERIUM VASACCIENSE Cope.

This species differs from the *H. venticolum* in its deep mandibular ramus. A single specimen from the Big-Horn presents the same proportions. The posterior inferior molar is rather short.

HYRACOTHERIUM VENTICOLUM Cope.

Bulletin U. S. Geol. Survey, Terrs., 1881, 198.

Fifteen individuals of this species are included in the collections.

HYRACOTHERIUM ANGUSTIDENS Cope.

This was a very abundant species. Mr. Wortman's collection contains jaws and teeth of twenty individuals sufficiently well preserved for identification, and a large number of other pieces of jaws, etc., which may be reasonably inferred to belong here.

In my report on the Wind River collection*, I noticed three varieties of this species, which differ in the depths of the ramus at the line of junction of the fourth and fifth molars. The numbers are 12, 14, and 15.5 mm. respectively. The lengths of the first true molar also vary from 7 to 6.5 and 7.5 mm. respectively. The last true molar measures in all 10.0 mm. The majority of the Big-Horn specimens agree with the second variety, but two others occur, one a little smaller, and the other a little larger than the average. The former measures ; length of last molar .0090 ; of

* Bulletin U. S. Geol. Survey Terrs. VI, 1881, p. 198.

first molar .0067 ; depth of ramus at M. I, .0120. The dimensions of the larger variety are : length of M. iii, .110 ; of M. i, .0067 ; depth ramus .0165. The New Mexican forms originally described, exhibit combinations of several of these measurements.

PACHYNOLOPHUS VENTORUM Cope.

Bulletin U. S. Geol. Surv. Terrs., 1881, p. 197. American Naturalist, 1880, p. 747.

One mandibular ramus.

PACHYNOLOPHUS POSTICUS, sp. nov.

Both rami of a mandible represent this large species. They are somewhat injured, and the crowns of five of the molars only can be distinctly seen. The latter display the characters seen in the *P. ventorum* and other species of the genus. The transverse crests are well characterized, and the valley between them uninterrupted. They are closed at the inner extremity by a low ridge nearly at right-angles with the cross crest posterior to them, as in the species of *Rhinocerus*. The anterior of these bounds an anterior ledge, which is quite large on the last true molar. The latter has a rather narrow, but prominent heel, which rises posteriorly. The fourth premolar has an anterior ledge, and wide heel with a diagonal crest which is median in front. The third premolar is similar, but smaller. The only cingulum is seen on the anterior part of the external side of all the true molars.

Measurements.		M.
Length of crowns of posterior six molars		.0700
" " true molars		.0440
Diameters P-m. iv	anteroposterior	.0095
	transverse	.0070
Diameters M. ii	anteroposterior	.0130
	transverse	.0095
Diameters M. iii	anteroposterior	.0180
	transverse anteriorly	.0092
Depth ramus at P-m. ii		.0280
" " M. ii		.0310

ARTIODACTYLA.

MIOCLÆNUS BRACHYSTOMUS, sp. nov.

Char. gen. The typical specimen of this species is represented by all the molar dentition of both jaws excepting the anterior three superior premolars. It also includes pelvis, femur, the distal parts of the tibia and fibula, the entire tarsus and the proximal portion of the metatarsus.

The dental characters conform precisely to those of the other species of *Mioclænus*. There is but one internal cusp of the superior true molars, and the intermediate tubercles are present. The fourth premolar has one external and one internal lobe. The inferior premolars have simple crowns without interior cusps or tubercles.

The characters of the tarsus are of much interest, and demonstrate that *Mioclænus* is the oldest type of artiodactyle yet discovered, and that it is not altogether primitive in some of its characters. Members of this order have been found by Cuvier in the upper Eocene (*Dichobune, Anoplotherium,* etc.), but none have been determined as yet from the Suessonian of America. A species represented by teeth from the Siderolithic beds of Switzerland have been referred to *Dichobune* (*C. campichii* Pict.); but dental characters alone are not sufficient to distinguish that genus from *Phenacodontidæ**. Dr. Lemoine found astragali of a small Artiodactyle in the Suessonian of Reims, and has referred them to his supposed Suilline *Lophiochœrus peroni.* I have reported an astragalus from the Wind River formation of Wyoming Territory, which is almost exactly similar to those found by Lemoine. The specimen now described, enables me to characterize with some degree of completeness this interesting form, which precedes in time all the known American *Artiodactyla.*

The characters of the tarsus are typically those of the order *Artiodactyla.* The astragalus exhibits a distal trochlea which is continuous with the sustentacular facet, and which articulates with both cuboid and navicular. The distal portion of the fibula is free from the tibia, and its shaft becomes very slender, It is possible that a more perfect specimen would display it as continuous, Its distal extremity articulates with the ascending tuberosity of the calcaneum. The cuboid facet of the latter is narrow. The cuboid and navicular bones are distinct from each other and from the cuneiforms. The mesocuneiform is shorter than the ectocuneiform, and *is coössified with it.* There are probably four metatarsals. The median pair are distinct, but appressed, their section together, sub-circular. The ateral metatarsals are slender, the external one is wanting, but its facet on the cuboid bone is very small.

These characters are in general similar to those of the genus *Dichobune,* but Cuvier† does not state whether the cuneiforms are coössified in that genus or not. They are united in Anoplotherium.‡ *Mioclænus* differs from *Dichobune* in the presence of but one internal tubercle of the superior molars, and in the single external tubercle of the superior premolars. Both genera are referable to a family to be distinguished from the *Anoplotheriidæ* by the presence of the external digits. This has been already named by Gill the *Dichobunidæ.*

Char. specif. The bones are about two thirds the size of those of the Javan musk-deer (*Tragulus javanicus*). The transverse extent of the superior true molars is greater than the anteroposterior. The composition of the last molar is like that of the others. The external tubercles are lenticular in section and the emargination which separates them is apparent on the external face of the crown. The intermediate tubercles are small, and are entirely distinct from the large external tubercle. There

* See American Naturalist, 1881, December.

† Ossemens Fossiles, v, p. 183.

‡ Gaudry Enchainements d. Regne Animal, p. 147.

is a distinct cingulum which is only wanting from the inner base of the crown. The fourth superior premolar has a trilobate outline of the base of the crown, the base of the inner lobe being contracted where it joins the external part of the crown. The internal tubercle is conic, with a prolongation outwards and forwards. Intermediate tubercle not distinct. External, anterior, and posterior cingula.

In the inferior true molars the external tubercles wear into crescents, The crowns increase in size posteriorly, which is the reverse of the order of enlargement in some of the other species of the genus. The fifth tubercle of the last molar is rather small, but is well distinguished from the other cusps. The internal median cusp is small, the external median. large. The premolars are not so much larger than the true molars in this as in the typical species of the genus. The second and third are more elongate on the base than the fourth. The latter is also less compressed than those that precede it. It has a short wide heel, and a small anterior basal tubercle. In the second and third premolars the posterior edge of the principal cusp is sharp, and descends gradually to the posterior base of the crown. Both have small acute anterior basal tubercles. The first inferior premolar is one-rooted, and has a simple crown directed somewhat forwards. It is separated from the second by a short space. The teeth anterior to this point are lost.

Measurements.		M.
Length posterior four superior molars		.0182
Diameters P-m. IV	anteroposterior	.0040
	transverse	.0042
Diameters M. II	anteroposterior	.0043
	transverse	.0060
Diameters M. III	anteroposterior	.0040
	transverse	.0060
Length of inferior molars		.0330
" "	premolars	.0192
" "	P-m. III	.0055
" "	P-m. IV	.0045
Diameters M. I.	anteroposterior	.0040
	transverse	.0033
Diameters M. III	anteroposterior	.0052
	transverse	.0040
Depth of ramus at P-m. I		.0047
" "	M. II	.0090
Length of astragalus		.0102
Width of trochlea behind		.0048
Diameters of cuboid	length	.0070
	width of middle	.0040

MIOCLÆNUS ETSAGICUS, sp. nov.

This, the largest species of the genus, is represented by the two rami of

a mandible of an adult animal in good preservation. In their robust character the premolar teeth resemble those of the *M. turgidus*, but are not relatively so large, nor is the last true molar relatively so small, as in that species. The heel of the third premolar is obsolete, and that of the fourth is a wide cingulum. Neither exhibit an anterior basal tubercle, and in both the principal cusp is stout. The true molars widen posteriorly to the anterior part of the last molar. The latter contracts rapidly to a narrow heel. The tubercles are all subconic, and the median ones of the last molar are small. There are no cingula, and the enamel is smooth.

The ramus is not robust, and is of moderate depth. Its inferior border rises below the middle of the last molar tooth, and posteriorly. There is a "mental" foramen below the contact of the fourth premolor and first true molar.

Measurements.		M.
Length of bases of six posterior molars		.047
" " three premolars		.024
" " P-m. II		.009
" " P-m. IV		.008
" " P-m. IV		.005
Diameters basis of M. II	anteroposterior	.0075
	transverse	.0070
Diameter basis M. III	anteroposterior	.0084
	transverse	.0070
Depth of ramus at P-m. II		.0080
" " M. II		.0140

This species is named from the Crow Indian name of the Big-Horn river, *Etsagie.*

Concluding Remarks.

The paleontologist who has examined the preceeding list, will readily perceive that it represents fully the Wasatach fauna, with little admixture of earlier or later forms. The only genus which belongs to the Bridger or middle Eocene, which occurs in the Big-Horn basin, is *Pappichthys*, The characteristic Bridger genera *Hyrachyus, Palæosyops, Uintatherium*, and the *Tillodonta*, are absent, and their place is taken by *Phenacodus, Hyracotherium, Coryphodon* and *Tæniodonta*, as in New Mexico. Several genera are, as elsewhere, common to the two horizons, and two species cannot be distinguished in the parts preserved. Such as *Hyopsodus paulus* and *H. vicarius*. A closer comparison may be made with the Wind-River group, on which I published a report in the Bulletin of the U. S. Geological Survey of the Territories.* The following genera found in that formation have not been obtained from the Big-Horn. *Protopsalis, Lambdotherium, Palæosyops, Hyrachyus.*† Genera of the Big-Horn not obtained from the Wind-River: *Cynodontomys, Anaptomorphus; Mesonyx,*

*1881, Feb. p. 201.

† Since making my report on the Wind-River fauna, I have found the anterior part of the lower jaw of a species of this genus.

Deltatherium, Oxyæna; Manteodon, Ectacodon, Metalophodon; Anacodon, Oligotomus, Systemodon; Mioclænus. Three of these genera have been found in the Bridger, and five have been obtained in the lower Eocene of New Mexico. Five of the genera are new to science.

An especial feature of the Big-Horn collection, as distinguishing it from those brought from other regions of the Wasatch formation, is the presence of numerous species of *Phenacodus*, and of new and rare species and genera of *Coryphodontidæ*.

II. The Fauna of the Catathlæus Beds or Lowest Eocene of New Mexico.

A number of new species and genera from this horizon were described in my Paleontological Bulletin No. 33. The present paper adds a few to this list. Up to the present time no species of *Coryphodon*, and but few specimens of *Hyracotherium* have been discovered in this formation, thus exhibiting a marked contrast to the Wasatch beds. The predominant genus is *Catathlæus*, which is represented by one very abundant species. The genera of *Creodonta* are mostly distinct from those of the Wasatch. The Diplarthrous Perissodactyla, so numerous in the Wasatch, are rare here. The genus which is well represented in both formations, is *Phenacodus*; and *Mioclænus* occurs in both. *Mesodonta* are much less numerous than in the Wasatch, and *Amblypoda* have not yet certainly been found.

This is the only Tertiary formation where the Laramie genus *Champsosaurus* occurs. It is represented by three species.

Psittacotherium multifragum Cope.

American Naturalist, 1882, p. 156, Jan. 25th.

An interesting new form of this sub-order has been found in the *Catathlæus* beds (probably the Puerco formation) of New Mexico. It differs widely from the two genera hitherto known, *Anchippodus* and *Tillotherium.* Owing to the absence of the superior dental series, it is not possible to be sure which is the canine. The inferior dental formula may be therefore written, I. 2; C. 1; P-m. 3; M. 3; or I. 3; C. 0; P-m. 3; M. 3; or I. 3; C. 1; P-m. 2; M. 3. The first and second incisors are large and rodent-like, growing from persistent pulps; the second are the larger. The third, or canines, are small and probably not gliriform. There is no diastema. The first premolar (or canine) has a compressed crown with two cusps placed transversely to the jaw axis, and has a complete enamel sheath, and probably two roots. The succeeding tooth is also transverse, and is two-rooted, judging from the alveolus. The first and second true molars are rooted, and the crown consists of two transverse separated crests, each partially divided into two tubercles. On wearing, the grinding surface of each assumes the form of a letter B with the convexities anterior. The last inferior molar is injured. The rami are short, and the symphysis deep and recurved.

Specific characters. The base of the coronoid process is opposite the junction of the second and third true molars. The ramus is deep and mod-

erately stout. The enamel of the first incisor does not extend below the alveolar border, at the internal and external faces, and does not reach it at the sides. It has a few wrinkles on the anterior face. The anterior enamel face of the second incisor is thrown into shallow longitudinal grooves with more or less numerous irregularities from the low dividing ridges. There is a deeper groove on each side of the tooth, and there are about a dozen ridges between these on the anterior face. Both cusps of the first premolar are conic, and the external is the larger. The second true molar is a little smaller than the first. The enamel of the premolars and molars is smooth, and there are no cingula.

Probable length of dental series, .0750; diameters of I. I: anteroposterior, .0120, transverse, .0066; diameters I. 2: anteroposterior, .0160, transverse, .0115; diameters P-m. I: anteroposterior, .0072; transverse, .0130; diameters of M. ii. anteroposterior, .0090, transverse, .0090. Length of true molars, .0038; depth of ramus at M. ii, .0360.

The short deep jaws of this animal must have given it a very peculiar appearance, not unlike that of a parrot in outline.

PSITTACOTHERIUM ASPASIÆ, sp. nov.

Represented by two mandibular rami of two individuals, one adult, the other nearly so, but with the last inferior molar not fully protruded. The latter specimen must be used for description, as it presents two molar teeth, while the other specimen has lost them.

The most obvious difference from the *P. multifragum* is its inferior size, which can be readily perceived from the measurements given. The posterior crest of the molars appears to have less transverse extent than in the larger species. This crest in the last inferior molar has a curved crenate edge, with a small conic tubercle at its external extremity. The anterior crest consists of two conic tubercles, whose apices converge, but whose bases are closely appressed, and only distinguished by a superficial fissure. The valley between the crests is uninterrupted. The preceding molar is larger, and its posterior crest is like that of the lost molar. The apex of the anterior crest is broken off.

The ramus deepens rapidly forwards, and contains the enormous alveolus for the incisors. The coronoid process leaves the alveolar border at the line separating the last two molars, or, in the smaller specimen, a little anterior to this point, and is quite prominent. The masseteric fossa is well marked, but shallows gradually anteriorly and inferiorly.

Measurements.

	M.
No. 1.	
Depth of ramus at penultimate molar	.027
Width of last molar anteriorly	.008
Length of crown of do.	.009
No. 2.	
Depth of ramus of penultimate molar	.029
" " at P-m. ii	.043
Length of five consecutive alveoli	.047

From the Puerco bed of N. W. New Mexico.

TRIISODON HEILPRINIANUS, sp. nov.

This species may be readily recognized as smaller than the *T. quivirensis,* and as having the anterior inner cusp of the inferior true molar of larger proportions than in the corresponding teeth of the latter species. It is only represented in my collection by a portion of a lower jaw, which supports only one well preserved molar. As the fourth premolar is not present, it is not positively ascertained that the species does not belong to *Ictops.*

The anterior cusp is very low, and is nearer the inside than the middle of the anterior border. The principal anterior cusps are opposite, and the external is a little the larger. The heel is larger than the basis of the anterior cusps, and has convex borders. Its internal border supports three tubercles, and the external border rises into a cutting lobe with lenticular section. Enamel smooth. No cingula, but the external base is injured.

Measurements.

			M.
Diameters of inferior molar	vertical	of cusps	.0070
		of heel	.0052
	anteroposterior		.0110
	transverse		.0065

Puerco beds of New Mexico.

Dedicated to my friend, Professer Angelo Heilprin, of Philadelphia.

SARCOTHRAUSTES ANTIQUUS, gen. et sp. nov.

Char. gen. We have in evidence of the characters of this genus, the last two superior molars, the last one lacking the crown; and parts of both mandibular rami, which exhibit teeth as far posteriorly as the first true molar inclusive; all belonging to one individual. A part of a skeleton of a second individual, which includes a fragment of lower jaw, belongs probably to this species.

Sarcothraustes resembles both *Amblyctonus* and *Mesonyx,* but it is probably to the latter genus that it is allied. The last superior molar is transverse, much as in *Oxyæna.* The crown of the penultimate is subtriangular and transverse. It has two external subconic cusps and a single internal lobe, whose section on wearing is a V, each branch of the face extending to the base of the corresponding external tubercle. There are three small inferior incisors, and a large canine. There are probably only three inferior premolars, the first one-rooted. The crown of the second has no heel. The crown of the third has a short wide heel. The crown of the first true molar consists of an anterior elevated cone and a posterior heel. The latter is wide, having a posterior transverse, as well as a longitudinal median keel. The fragments of the supposed second individual include two large glenoid cavities with strong preglenoid crests, as in *Mesonyx.*

As compared with *Mesonyx,* this genus differs in the V-shaped crest of the penultimate superior molar; in *Mesonyx* it is represented by a simple cone. The last superior molar of *Mesonyx* is triangular and not transverse, but the composition of the crown of that tooth in *Sarcothraustes* must be

known before the value of this character can be ascertained. If the view that *Sarcothraustes* has but three inferior premolars be correct, this character distinguishes it from *Mesonyx*, as do also the transversely expanded heels of the molars. The family *Mesonychidæ* may be for the present regarded as embracing the three genera of *Sarcothraustes, Mesonyx* and *Dissacus*.*

Char. Specif. The penultimate superior molar has a strong posterior cingulum which commences within the line of the internal bases of the external cusps, and rises into considerable importance behind the internal cusp. There is also an anterior cingulum which does not rise internally, and which is continuous with a strong external basal cingulum. The latter passes round the posterior base of the posterior cone, and runs into the posterior branch of the internal V. The posterior cone is smaller than the anterior cone, and its apex is well separated from the latter. The appearance of this tooth is something like that of a carnivorous marsupial.

The symphysis mandibuli slopes obliquely forwards, and is united by coarse suture. The ramus is stout and deep, as compared with the size of the molar teeth. The roots of the teeth are relatively large, especially those of the first two premolars. The crown of the canine is lost. The first premolar points forwards, nearly parallel with the canine, and divergent from the second premolar. The crown of the second premolar is small and subconic, and has a rudimental heel, and no anterior basal tubercle. The first true molar resembles considerably that of *Mesonyx*. There is a small anterior basal tubercle on the inner side of the principal cusp. The expansion of the heel is transverse only, there being no longitudinal lateral edges or tubercles. The enamel is obsoletely, rather coarsely wrinkled. There are two rather large mental foramina; the posterior below the anterior root of the first true molar, and the anterior below the posterior root of the second premolar.

Measurements.

		M.
Diameters of superior M. ii	anteroposterior externally	.015
	transverse	.024
Anteroposterior diameter of base of M. iii		.0095
Anteroposterior diameter base of crown of inferior canine		.020
Length of bases of three inferior premolars		.038
Diameters inferior M. i.	anteroposterior	.019
	transverse	.0095
	vertical	.0110
Depth of ramus at P-m. iii		.0520
Width " "		.022

* American Naturalist, Dec., 1881.

CHAMPSOSAURUS PUERCENSIS, sp. nov.

I have already announced the discovery * of this Laramie genus in the Puerco beds of New Mexico, and described a species, *C. australis*, from that region. I now introduce two additional species from the same horizon. One of these is represented by a number of fragments which include three dorsal and four caudal vertebræ of apparently one individual. They represent an animal of larger size than any of those heretofore referred to *Champsosaurus*, excepting the *C. vaccinsulensis*. In all of the vertebræ the neural arch is more or less coössified with the centrum, and the animal had probably reached its full size.

One of the dorsal *centra* is split vertically and longitudinally, and shows the structure already figured by Leidy in the *Ischyrosaurus antiquus* † Leidy. The surface exposed displays two diagonal lines of fissure crossing each other at right angles. They indicate clearly the mode of origin of this amphiplatyan type of centrum. The centrum is first deeply amphicœlous as in the Theromorphous reptiles of the Permian. The conical cavities are filled by the ossification of the remaining portions of the notochord, forming a conical body which always remains distinct from the remainder of the centrum.

The articular faces of the dorsal centra are a little wider than deep, and the depth about equals the length of the body. They are not nearly so depressed as those of *C. australis*, and their outline is different. This is wider above and narrows below ; in both *C. australis* and *C. saponensis* the inferior outline is part of a circle. None of the dorsals preserved are keeled below. There is a fossa below the diapophysis which has a subvertical posterior boundary. The general surface (somewhat worn) does not display wrinkles near the articular faces. An anterior dorsal has a short compressed diapophysis with a narrow figure 8 articular surface, and its superior border is in line with the roof of the neural canal. The anterior caudals have subround articular faces ; the posterior are more oval and the bodies compressed. With greater compression, the length increases.

Measurements.		M.
Diameters of an anterior dorsal	anteroposterior	.025
	vertical	.025
	transverse	.030
Height of costal facet of do		.021
Diameters neural canal do.	vertical	.007
	transverse	.009
Diameters anterior caudal	anteroposterior	.024
	vertical	.021
	transverse	.021
Diameters posterior caudals	anteroposterior	.025
	vertical	.018
	transverse	.018

* American Naturalist, 1881. p. 669.

† Transac. Amer. Philos. Soc. 1860.

The typical specimen was found by Wm. Baldwin near the Puerco river, west of the Nacimiento mountain, New Mexico, in the typical locality of the Puerco formation.

CHAMPSOSAURUS SAPONENSIS, sp. nov.

Represented in my collection by six cervical and several dorsal vertebræ, one only of the latter with well preserved centrum, parts of ribs, and various other bones, whose reference is not yet certain.

The cervical vertebræ include the os dentatum or centrum of the atlas. This shows its streptostylicate character in its distinctness from both the centrum and the free hypapophysis of the axis. Nevertheless it is more Crocodilian than Lacertilian in form. Its anterior face is transverse, with a little lip carrying forwards the floor of the neural canal, below which the face is leveled posteriorly. The inferior surface is narrow and transverse, as though adapted for the anterior part of the hypapophysis of the axis. At each side it terminates in a prominent tuberosity, as though for the attachment of a cervical rib as in the Crocodilia. The anterior face is bounded posteriorly by a transverse groove which terminates in a fossa on each side. The posterior articular face of the os dentatum is wider than deep. The lateral angles of the superior face are rounded, and its median portion is concave.

The axis displays a large facet for the hypapophysis. Behind it the inferior middle line is not keeled, but is coarsely wrinkled longitudinally. The posterior edge of the hypapophysial facet is the most prominent part of the inferior surface. The posterior articular face is deeper than wide. This is true of the faces of all the cervical vertebræ. The latter gradually increase in size posteriorly, and the dorsals become larger. The articular faces of all the centra are regularly rounded and not contracted below. The five cervicals are strongly keeled below ; the keel of the third centrum being split up anteriorly into narrow ridges. On the sixth the keel is more prominent and acute. The dorsal is not keeled. A trace of the parapophysis appears low down on the fourth cervical ; it rises and becomes prominent as a round tuberosity on the fifth and sixth. It appears on the superior edge of the centrum of the dorsal vertebra, where it is connected with the diapophysis. It is near the middle of the length of the centrum, and not near the anterior border as in *C. australis.*

The surfaces of the vertebræ are very smooth excepting where thrown into coarse wrinkles near the borders of the articular faces and near the hypapophysis. The edges of the articular faces are somewhat revolute on the sides in the cervicals, but not on the dorsal. They are impressed in the centre to a point, most strongly so as we pass forwards in the series. There is a fossa below the space anterior to the parapophysis of the dorsal vertebra, which is abruptly bounded below by a horizontal angle. A separate neural spine perhaps of a cervical vertebra, has the following form. It is stout, and is contracted rather abruptly at the apex from behind forwards. The section is broadly lenticular, angulate in

front, and truncate behind. The posterior face has several longitudinal wrinkles, including a median raised line, and there are some more irregular wrinkles on the sides.

Measurements of vertebræ.			M.
Anterior face of os dentatum	width		.025
	depth (oblique)		.012
Posterior face of os dentatum	width		.020
	depth		.018
Length os dentatum above			.014
Diameters axis	posterior face	depth	.022
		width	.020
	length		.0185
Hypapophysial facet os dentatum	depth		.008
	width		.014
Diameters fourth cervical	length		.022
	anterior	depth	.0225
		width	.022
Diameters sixth cervical	length		.0215
	anterior	depth	.0245
		width	.0235
Spaces between parapophysis and diapophysis of do			.0040
Diameters of dorsal	length		.0265
	anterior	depth	.0260
		width	.0265
Height of neural spine of ?, from postzygapophysis			.0210
Anteroposterior width of do. at base			.0100

The portions of ribs are separated heads and shafts. The former are double and therefore cervical, and are quite large. If the shafts belong to them, the neck of this species must have been wide. The shafts are slender and are of dense bone. The section is oval at the middle, but towards the distal extremity becomes flattened and grooved and delicately line ridged on one side. The extremities of the long bones are without condyles but have concave surfaces like those of the ribs. The bodies are robust and angular. They may be abdominal ribs of unusual stoutness. From the Puerco beds, D. Baldwin.

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508.

v 25. 1882.

Cope

Paleontological Bulletin, No. 35.

THE CLASSIFICATION

OF

THE UNGULATE MAMMALIA.

(Read before the American Philosophical Society, May 19, 1882.)

THIRD CONTRIBUTION

TO

THE HISTORY OF THE VERTEBRATA

OF THE PERMIAN FORMATION OF TEXAS.

(Read before the American Philosophical Society, September 15, 1882.)

SYNOPSIS OF THE VERTEBRATA

OF THE

PUERCO EOCENE EPOCH.

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ON THE

SYSTEMATIC RELATIONS

OF THE

CARNIVORA-FISSIPEDIA.

(Read before the American Philosophical Society, October 20, 1882.)

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The Classification of the Ungulate Mammalia. By E. D. Cope.

(Read before the American Philosophical Society, May 19, 1882.)

In the present essay the osseous system is chiefly considered, and of this, the structure of the feet more than of any other part of the skeleton. The ungulata are here understood to be the hoofed placental Mammalia with enamel covered teeth, as distinguished from the unguiculate or clawed and the mutilate or flipper limbed, and the edentate or enamelless, groups. The exact circumscription and definition is not here attempted, though probably the brain furnishes an additional basis of it in the absence of the crucial, parietoöccipital, calcarine fissures, etc. Suffice it to say that it is on the whole a rather homogeneous body of mammalia, especially distinguished as to its economy by the absence of forms accustomed to an insectivorous and carnivorous diet, and embracing the great majority of the herbivorous types of the world.

The internal relations of this vast division are readily determined by reference to the characters of the teeth and feet, as well as other less important points. I have always insisted that the place of first importance should be given to the feet, and the discovery of various extinct types has justified this view. The predominant significance of this part of the skeleton was first appreciated by Owen, who defined the orders *Perisso-*

dactyla and *Artiodactyla*. Professor Gill* has also used these characters to a large extent, but without giving them the exclusive weight that appears to me to belong to them. Other authors have either passed them by unnoticed, or have correlated them or subordinated them to other characacters in a way which has left the question of true affinity and therefore of phylogeny, in a very unsatisfactory condition. Much light having been thrown on these points by recent discoveries in paleontology, the results, as they appear to me, are here given.

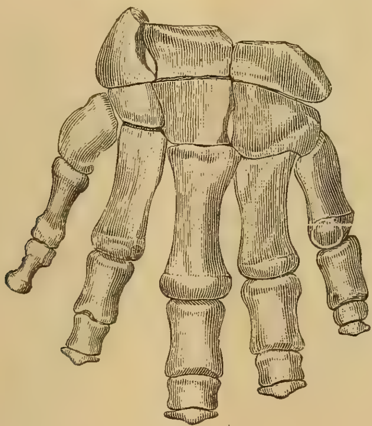


Fig. 1.

Fig. 1.—Left anterior foot of *Elephas africanus* (from De Blainville).

Carpus.—It is well known that in the *Perissodactyla* and *Artiodactyla,* the bones of the two rows of the carpus alternate with each other; that the lunar for instance rests on the unciform, and to a varying degree on the magnum, and that the scaphoides rests on the magnum and to some degree on the trapezoides and trapezium. It is also known that in the *Proboscidea,* another state of affairs exists; *i. e.*, that the bones of the two rows do not alternate, but that the scaphoides, lunar and cuneiform, rest directly on the trapezium and trapezoides, the magnum, and the unciform respectively. The preceding characters are sometimes included in the definitions of the respective orders. Further than this they have not been used in a systematic sense.

Professor Gill says of the carpus of the *Hyracoidea,* "carpal bones in two interlocking rows; cuneiform extending inwards (and articulating with magnum); * * * unciform and lunar separated by the interposition of the cuneiform and magnum." Professor Flower† gives a figure which justifies these statements, but neither the one nor the other agree with my

* Arrangement of the families of Mammals prepared for the Smithsonian Institution. Miscellaneous Collections 230. Nov., 1872.

† Osteology of the Mammalia, p. 266; fig. 92.

specimens. In the manus of a *Hyrax capensis* (from Verreaux, Paris), I find the following condition of the carpus. The bones of the two series are articulated consecutively, and not alternately; they do not interlock, but inasmuch as the magnum is a little narrower than the lunar, the latter is just in contact (anteriorly) with the trapezoides (centrale) on the one side, and the unciform on the other. My specimen agrees with Cuvier's figure of *Hyrax capensis* in all respects. It is probable that Professor

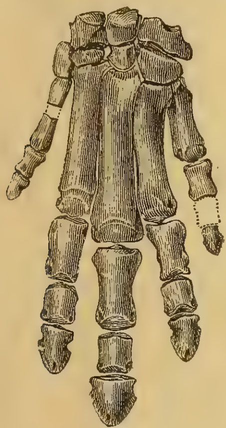


FIG. 2.

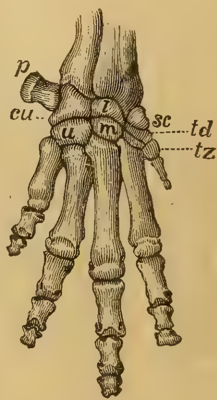


FIG. 3.

FIG. 2.—Left anterior foot of *Phenacodus primævus*, one-third natural size (original).

FIG. 3.—Right anterior foot of *Hyrax capensis*; (from Cuvier). *Sc.* scapuloid bone; *l.* lunar; *cu.* cuneïform; *p.* pisiform; *tz.* trapezium; *td.* trapezoides; *m.* magnum; *u.* unciform.

Flower has figured some other species under that name, which besides its peculiarities, is of smaller size than the *H. capensis* (see Fig. 3).

In April, 1875* I described the manus of *Coryphodon* (Bathmodon), showing that the lunar was supported below by the magnum and by parts of the unciform. This carpus has the characters of that of *Hyrax capensis*, with the last named articulation more extensive. This was the first description of the carpus of the *Amblypoda*. In February, 1876,† Professor Marsh described the carpus of *Uintatherium* (*Dinoceras*), and asserted that the bones "form interlocking series." He however states that "the magnum is supported by the lunar and not at all by the scaphoid," a state of things which does not belong to the interlocking carpus. The trapezoides does not join the lunar, but the unciform does so, as in *Coryphodon*. Professor Marsh's figure as to the articu-

* Systematic Catalogue of the vertebrata of the Eocene of New Mexico, p. 24 (U. S. Geol. Survey W. of 100th Mer.).

† Amer. Journal Sci. Arts. xi, p. 167; pl. vi., fig. 2.

lations of the magnum does not agree with his description, as it makes that bone articulate with the scaphoid. The second description is however correct, and the carpus is identical with that of *Coryphodon.* (Fig. 4.)

In the *American Naturalist,* June, 1882,* I have shown that the carpus of the *Condylarthra* is essentially like that of the *Hyracoidea.* (Fig. 2.)

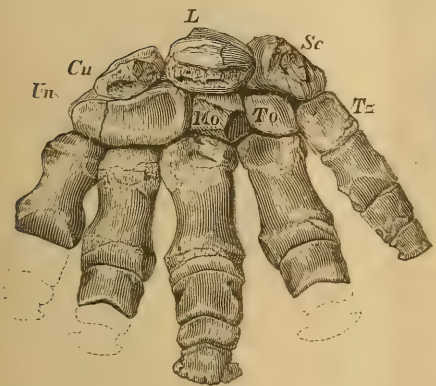


Fig. 4.

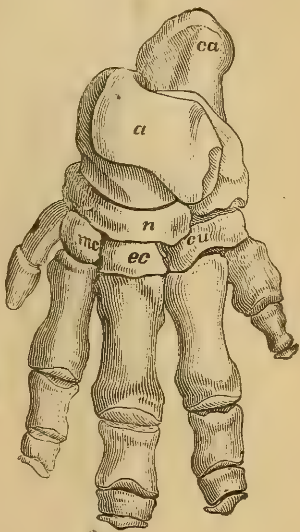


Fig. 5.

Fig. 4.—Manus of *Coryphodon* (original). The cuneïform is imperfect.

Fig. 5.—Left posterior foot of *Elephas indicus*; (from Cuvier). *ca.* calcaneum; *a.* astragalus; *n.* navicular; *cu.* cuboid; *ec.* ectocuneïform; *mc.* mesocuneïform.

Tarsus.—In the tarsus of the *Perissodactyla* and *Artiodactyla* it is well understood that the cuboid extends inwards so as to articulate with the astragalus, giving the latter a double distal facet. It is also well known that the astragalus of the *Proboscidea* has but a single distal articulation, that with the navicular. It is, however, true that the cuboid is extended inwards, but that it articulates with the distal extremity of the navicular instead of that of the astragalus. It was shown by Cuvier that the astragalus of the *Hyracoidea* articulates with the navicular only, and that the cuboid is not extended inwards so as to overlap the latter. In 1873 Marsh† stated that the astragalus of the *Amblypoda* articulates with both cuboid and navicular. Finally I discovered in 1881,‡ that the astragalus of the *Condylarthra* articulates with the navicular only and that the cuboid articulates with

* Page 522.

† American Journal Science and Art, January, 1873.

‡ American Naturalist, 1881, p. 1017.

the calcaneum only. In the tarsus then there are four types of articula-

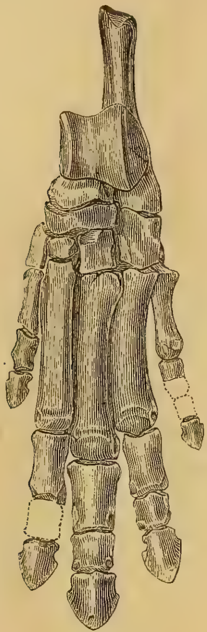


Fig. 6.

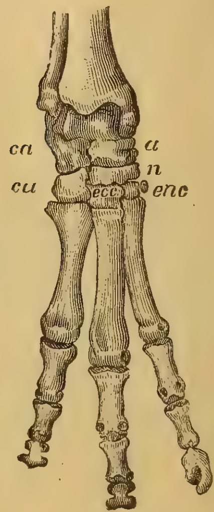


Fig. 7.

Fig. 6.—Left posterior foot of *Phenacodus primævus*, one-third natural size (original).

Fig. 7.—Right posterior foot of *Hyrax capensis* (from Cuvier). *Ca.* calcaneum; *a.* astragalus; *n.* navicular; *cu.* cuboid; *ecc.* ectocuneiform; *mc.* mesocuneiform; *enc.* entocuneïform.

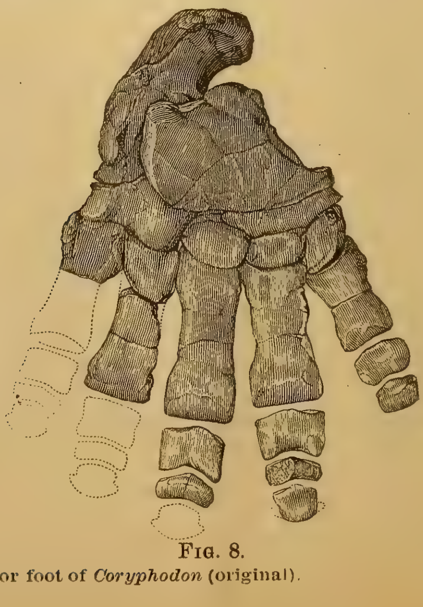


Fig. 8.

Fig. 8.—Posterior foot of *Coryphodon* (original).

tion, which are typified in the *Condylarthra*, the *Proboscidea*, the *Amblypoda* and the *Artiodactyla* respectively. (Figs. 5–9.)

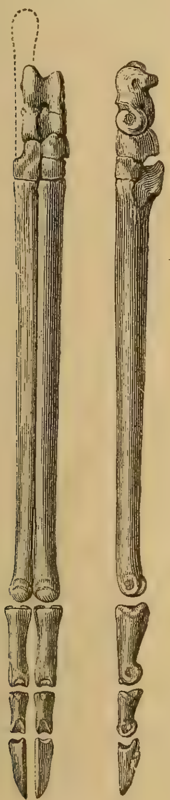


FIG. 9.

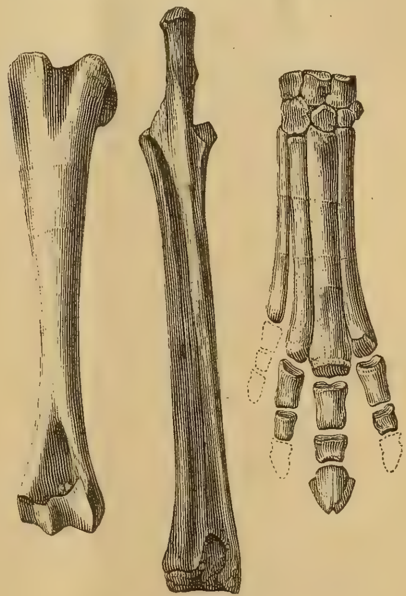


FIG. 10.

FIG. 9.—Hind foot of *Poëbrotherium labiatum* (original).
FIG. 10.—Fore leg and foot of *Hyracotherium venticolum* (original).

Orders.—From the preceding considerations we derive the following definitions of the primary divisions of the Ungulata, which should be called orders. In the first place I find the diversity in the structure of the carpus to be greater in the relations of the magnum and scaphoides, than in the relations between the unciform and the lunar. In other words the trapezoides and magnum are more variable in their proportions than is the unciform. This is directly due to the fact that the reduction of the inner two digits is more usual than the reduction of the external two. I therefore view the relations of these bones as more characteristic. In the tarsus the really variable bone is the cuboid. It is by its extension inwards

that the additional facet of the astragalus is produced. Its relations will therefore be considered rather than those of the astragalus in framing the following definitions :

Order I. Scaphoides supported by trapezoides and not by magnum, which supports lunar. Cuboid articulating proximally with calcaneum only.......... ....*Taxeopoda.*

Order II. Scaphoides supported by trapezoides, and not by magnum, which supports lunar. Cuboid extended inwards and articulating with the distal face of the navicular...........................*Proboscidea.*

Order III. Scaphoides supported by trapezoides and not by magnum, which with unciform, supports the lunar. Cuboid extended inwards and articulating with astragalus...................................*Amblypoda.*

Order IV. Scaphoides supported by magnum, which with the unciform also supports the lunar. Cuboid extended inwards so as to articulate with the astragalus..*Diplarthra.*

The sub-orders are defined as follows :

I. TAXEOPODA.

There are two, perhaps three sub-orders of the *Taxeopoda;* the *Hyracoidea,* the *Condylarthra,* and perhaps the *Toxodontia.** The *Toxodontia* are however not sufficiently known for final reference.† The sub-orders are defined as follows :

A postglenoid process ; no fibular facet of calcaneum, but an interlocking articulation between fibula and astragalus ; ungual phalanges truncate..*Hyracoidea.*

A postglenoid process ; no fibular facets on either calcaneum or astragalus ; a third trochanter of the femur ; ungual phalanges acuminate........ *Condylarthra.*

There are a good many other subordinate characters which distinguish the *Condylarthra,* which will be given in my forthcoming volume iv of the Hayden Survey, on the Tertiary Vertebrata of Western America.

II. PROBOSCIDEA.

There may be two sub-orders of this order, the *Proboscidea* and the *Toxodontia.* I do not know the Carpus of *Toxodon,* but if it does not differ more from that of the elephants than the tarsus does ; it is not entitled to subordinal distinction from the Proboscidea. The sub-order of *Proboscidea* is defined as follows :

A fibular articulation of the calcaneum ; no postglenoid process ; no third trochanter of femur.......................................*Proboscidea.*

* See my remarks on Toxodon, Proceedings Amer. Philosoph. Society, 1881, p. 402.

† The considerable resemblance between the dentition of *Toxodon* and *Hyrax* must not be overlooked.

III. AMBLYPODA.

The sub-orders of this order, as I pointed out in 1873, are two, defined as follows :

Superior incisor teeth ; no ali-sphenoid canal ; a third trochanter of femur ; *Pantodonta.*

No superior incisors, nor ali-sphenoid canal, nor third trochanter of femur ; *Dinocerata.*

The difference between the *Proboscidea* and the *Amblypoda* consists chiefly in that the navicular of the latter is shortened externally so as to permit the cuboid to articulate with the astragalus. The cuboid has the same form in both. The peculiar character of the navicular gives the astragalus a different form.

IV. DIPLARTHRA.

This order is called by some authors the Ungulata, but that name is also used in the larger sense in which it is here employed. This appears to be its legitimate application, as the name should, if possible, be used for hoofed Mammalia in general, as its meaning implies. The two well known sub-orders are the following :

Astragalus truncate distally ; number of toes odd, the median one the largest.. *Perissodactyla.*

Astragalus with a distal ginglymus ; number of toes even, the median two largest.. *Artiodactyla.*

Phylogeny.—The serial arrangement of the bones of the carpus and tarsus seen in the *Taxeopoda*, is probably the primitive one, and we may expect numerous accessions to that order on further exploration of the early Eocene epochs. The modification seen in the more modern orders of *Perissodactyla* and *Artiodactyla*, may be regarded as a rotation to the inner side, of the bones of the second carpal row, on those of the first. This rotation is probably nearly coincident with the loss of the pollex, as it throws the weight one digit outwards, that is on the third and fourth digits, rendering the first functionally useless to a foot constructed solely for sustaining a weight in motion. The alternation of the two rows of carpals clearly gives greater strength to the foot than their serial arrangement, and this may probably account for the survival of the type possessing it, and the extinction of nearly all the species of the type which does not possess it. Here is applied again the principle first observed by Kowalevsky in the proximal metapodial articulations. This author shows that the types in which the metapodials articulate with two carpal or tarsal bones, have survived, while those in which the articulation is made with a single carpal or tarsal have become extinct. The double articulation is, of course, mechanically the more secure against dislocation or fracture.

As regards the inner part of the manus I know of no genus which presents a type of carpus intermediate between that of the *Taxeopoda* and

Amblypoda on the one hand, and the *Perissodactyla* and *Artiodactyla* on the other. Such will however probably be discovered. But the earliest *Perissodactyla*, as for instance *Hyracotherium*, *Hyrachyus* and *Triplopus*, possess the carpus of the later forms, *Rhinocerus* and *Tapirus*. The order *Amblypoda* occupies an interesting position between the two groups, for while it has the carpus of the primitive type, it has the tarsus of the later orders. The bones of the tarsus alternate, thus showing a decided advance on the *Taxeopoda*. This order is then less primitive than the latter, although in the form of its astragalus it no doubt retains some primitive peculiarities which none of the known *Taxeopoda* possess. I refer to the absence of trochlea, a character which will yet be discovered in the *Taxeopoda*, I have no doubt.

The *Taxeopoda* approach remarkably near the *Bunotheria*, and the unguiculate and ungulate orders are brought into the closest approximation in these representatives. In fact I know of nothing to distinguish the *Condylarthra* from the *Mesodonta*, but the ungulate and unguiculate characters of the two divisions. In the *Creodonta* this distinction is reduced to very small proportions, since the claws of *Mesonyx* are almost hoofs. Some of the genera of the *Periptychidæ* present resemblances to the *Creodonta* in their dentition also.

The facts already adduced throw much light on the genealogy of the Ungulate Mammalia. The entire series has not yet been discovered, but we can with great probability supply the missing links. In 1874 I pointed* out the existence of a yet undiscovered type of Ungulata, which was ancestral to the *Amblypoda*, *Proboscidea*, *Perissodactyla* and *Artiodactyla*, indicating it by a star only in a genealogical table. This form was discovered in 1881, seven years later, in the *Condylarthra*. It was not until later† that I assumed that the *Diplarthra* are descendants of the *Amblypoda*, although not of either of the known orders, but of a theoretical division with bunodont teeth.‡ That such a group has existed is rendered extremely probable in view of the existence of the bunodont *Proboscidea* and *Condylarthra*. That the *Taxeopoda* was the ancestor of this hypothetical group as well as of the *Proboscidea*, is extremely probable. But here again neither of the sub-orders of this group represent exactly the ancestors of the known *Amblypoda*, which have an especially primitive form of the astragalus not found in the former. In the absence of an ankle-joint, the *Amblypoda* are more primitive than any other division of the Ungulata, and their ancestors are not likely to have been more specialized than they. It is probable that a third sub-order of *Taxeopoda* has existed which had no trochlea of the astragalus, which I call provisionally by the name of *Platyarthra*.

* Homologies and Origin of Teeth, etc., Journal Academy Nat. Science, Philada., 1874, p. 20.

† Report U. S. Geol. Survey W. of 100th Mer., p. 282, 1877.

‡ This hypothetical sub-order is called in the appended scheme, *Amblypoda Hyodonta*.

The preceding paragraphs were written in May of the present year. On my return home, September 1st, after an absence of three months, I find that various parts of the skeleton of *Periptychus** have reached my museum. On examination, I find that the astragalus of that genus fulfils the anticipation above expressed. *It is without trochlea*, and nearly resembles that of *Elephas.* As it agrees nearly with that of *Phenacodus* in other respects I only separate it as a family from the *Phenacodontidæ.* One other type remains to be discovered which shall connect the *Periptychidæ* and the hypothetical *Hyodonta,* and that is a Taxeopod without a head to the astragalus,—unless, indeed, the *"Hyodonta"* should prove to have such a head. I think the latter the less probable hypothesis, and hence retain the term *Platyarthra* for the hypothetical Taxeopod without trochlea or head of the astragalus.

These relations may be rendered clearer by the following diagram :

TAXEOPODA.

Condylarthra. Platyarthra.††

Hyracoidea.

PROBOSCIDEA. AMBLYPODA.

Hyodonta.†† Pantodonta.

Dinocerata.

DIPLARTHRA.

Perissodactyla. Artiodactyla.

Third contribution to the History of the Vertebrata of the Permian formation of Texas. By E. D. Cope.

(*Read before the American Philosophical Society, September 15, 1882.*)

Since the publication of my second contribution to this subject,‡ I have described four additional species. These are, in Bulletin of the U. S. Geological Survey of the Territories ;§ *Pantylus cordatus* and *Dimetrodon semiradicatus ;* in the American Naturalist,‖ *Eryops reticulatus* and *Za-*

* See American Naturalist, October, 1882

†† Hypothetical.

‡ Paleontological Bulletin, No. 32, Proceedings American Philosophical Society, 1880; the plates, 1881.

§ Vol. vi, 1881, p. 79.

‖ 1881, p. 1020.

trachys apicalis. The last two were not included in my catalogue of the Permian Vertebrata published previously* in the same year. The present paper adds some important points to this remarkable fauna, and explains the hitherto obscure relations of several genera.

DIADECTIDÆ.

The pelvis and sacrum of a species of this group are preserved in my collection, and they indicate further peculiarities of this group,

The sacrum consists of two vertebræ only, and is thoroughly united with the pelvis by its transverse processes. The latter are decurved on the inner side of the iliac bones, and the sutures which distinguish them from the latter and from each other, are not serrate. The inferior arch is robust, but very narrow anteroposteriorly. The acetabulum is entire in every respect, so that it is probable that both pubis and ischium are united undistinguishably in the arch. The pubis is perforated by the usual internal femoral foramen. The posterior edge is grooved, and it might be suspected that this marks the articulation of an ischium. The anterior edge is however grooved in the same way, so that the appearance is rather the position of muscular insertion. The spines of the sacral vertebræ are distinct, and have the usual form seen in *Diadectes.*

The two sacral vertebræ and the absence of obturator foramen, are characters of the suborder *Pelycosauria* in which the latter differs from the *Dicynodontia.* I am still inclined to question whether the extraordinary characters of the cranio-vertebral articulation I have described, justify the separation of the *Diadectidæ* as a third sub-order of the *Theromorpha,* which I have called the *Cotylosauria,*† or whether they are not due to the loss of a loosely articulated basioccipital bone.

EDAPHOSAURUS Cope, genus novum.

Apparently allied to *Pantylus.* Temporal fossæ not overroofed; surfaces of cranial bones not sculptured. Mandibular and maxillary teeth subequal. Posterior half of the mandibular ramus expanded inwards and supporting numerous closely arranged teeth. Pterygoid, or perhaps an internal expansion of the malar bones, supporting a dense body of teeth, corresponding to those of the lower jaw. Teeth subconical.

The single species of this genus in my possession shows the following characters of systematic importance. An arch extends from the parietal plane posteriorly and downwards to the external base of the quadrate. The specimen is not yet in a condition to show how much of this is parietal, and how much squamosal or opisthotic. The proximal half of the posterior part of this arch is a distinct element, perhaps a transverse process of the supraöccipital. A distinct element connects the basioccipital on each side with the quadrate. The articular extremity of the latter has

* American Naturalist Feb., 1881.
† American Naturalist, 1880, p. 304.

a deep anteroposterior concave emargination. There is a flat bone extending from it anteriorly which is apparently pterygoid rather than quadratojugal. The tooth bearing portion terminates opposite the middle of the basisphenoid.

The occipital condyle is undivided, and the basisphenoid presents the usual two divaricating protuberances to the basioccipital.

EDAPHOSAURUS POGONIAS, sp. nov.

Represented by the followsng portions of a skull; basis cranii with portion posterior to the middle of the parietal bone; left maxillary with dental plate, left mandibular ramus entire; various flat bones undetermined. There is also a body which may be the atlas with its arch somewhat dislocated. These pieces are in part covered with a thin layer of the red deposit of the Permian bed in which they occur.

The facial plate of the *os maxillare* is subvertical, so that the orbit is lateral. The latter is rather small. The malar bone is narrow, and is continuous with the dentigerous bone of the palate. The latter has a thickened posterior edge, which commences below the anterior part of the orbit, and extends posteriorly to the middle of the basisphenoid. Thence the border turns forwards. Its anterior edge is below the anterior border of the orbit, and the general form is a longitudinal oval. The maxillary teeth are somewhat weathered and obscured by a thin layer of matrix. The posterior ones are compressed-conic; the premaxillaries are four in number on one side, and are more nearly conic, and have incurved apices. The median premaxillary suture is, however, not clearly defined, so that the number of premaxillaries remains uncertain. The centre of the probable nostril measures one-third the distance from the premaxillary border to the anterior edge of the orbit. There are eight rows of (?) pterygoid teeth at the posterior fourth of the series. The teeth are subequal and obtuse, increasing a little anteriorly.

The mandibular ramus is robust, and the external face slopes inwardly and downwards. The external border rises a little above a few of the posterior teeth, but it is injured at the posterior of the coronoid process, so that its existence cannot be ascertained. The border then descends and turns inwards to the articulation, which is condyloid at its internal extremity. The inferior edge of the anterior part of the ramus becomes a median ridge below the condyloid region, and terminates in a short, compressed angular process. The symphysis is not coössified, and is convex downwards and forwards. The inferior part is subhorizontal, and forms the edge of a transverse plate which is separated from the vertical part of the ramus by a deep groove. The inner vertical face of the ramus is strongly convex, as is the corresponding edge of the symphyseal suture. The apices of the teeth are worn, but they were probably conic, the posterior gradually smaller and more obtuse. The interior face of packed teeth begins at the posterior two-fifths of the external series, and expands in-

wards posteriorly. It contains six longitudinal rows opposite the antepenultimate dentary tooth.

All the bony surfaces are smooth.

Measurements.	M.
Length of mandibular ramus (straight)	.162
" symphysis of do. (straight)	.038
" external dental series	.077
Width of ramus at dental pavement	.040
" skull at ends of OO. quadrata	.138
" extremity of O. quadratum	.024
" occipital condyle	.018
Length of superior dental pavement	.065
Width of basisphenoid posteriorly	.029

The supposed axis vertebra is longer than wide, and the centrum is deeply excavated posteriorly. Anteriorly it appears to have lost a piece—the centrum of the atlas, which, while fitting it closely, was not co-ossified with it. There is a flat horizontal convex ala in the place of a diapophysis, and an obtuse median hypapophysial angle. The neural spine is compressed, except posteriorly, where it is transversely expanded, terminating above in a short obtusely accuminate apex. From this apex an obtuse rib passes down the median line, and disappears above the neural arch, where the spine is somewhat narrower. The postzygapophyses are well developed and look downward.

Measurements of axis.	M.
Length of centrum below	.020
Width, including diapophyses	.035
Elevation of spine from postzygpophysis	.038
Width of do., posteriorly	.020

Remarks.—This interesting form is probably allied to *Pantylus*, which I have hitherto regarded as a Batrachian. The two genera may be placed in a special family of the Pelycosauria, to be called the *Edaphosauridæ*. This family will be distinguished from the *Clepsydropidæ* by the presence of more than one series of teeth on parts of the jaws. It is possible that *Helodectes* must be placed in it.

ECTOCYNODON Cope.

Paleontological Bulletin No. 29, p. 508.

A species now before me resembles in generic characters the type of this genus, *E. ordinatus*. That species was described as having the canine tooth near the middle of the maxillary bone, while in the present one it is near the anterior part of it, as in some other genera. In the typical species, as in the species to be described, the cranial bones are sculptured, and the temporal fossæ are overroofed. The sculptured surface as well as the canine teeth distinguish *Ectocynodon* from *Pariotichus* Cope and *Procolophon* Owen, which genera are otherwise related.

Ectocynodon aguti, sp. nov.

This reptile is much larger than the *Pariotichus brachyops*, and the anterior part of the cranium has a different form. The general shape of the head is much like that of a rodent mammal of the genus *Dasyprocta*. It is rather wide at the temporal regions, flat above, and narrowed and compressed anterior to the orbits. The muzzle is narrowed and obtuse, and the nostrils are terminal, and are lateral and a little anterior in direction. The maxillary alveolar edge is nearly straight, but the premaxillary edge, beginning below the posterior border of the nares, descends forward at an angle of 45°. Viewed from the front, the premaxillary border is a festoon, strongly convex downwards, and below the anterior part of the nostril. The suture separating the premaxillaries is distinct. The orbits are of moderate size, as in an aguti, and invade the superior frontal plane in a slight degree. The frontoparietal fontanelle is rather large.

The mandible is robust, and presents a short angle. It closes up behind the premaxillary lobate edge. Its teeth are concealed in the specimen. The maxillary teeth increase rapidly in size forwards. The premaxillaries commence smaller next the maxillaries, and increase in size to the first, which is a little larger than the anterior maxillary. The crowns are weathered away. The sculpture on the maxillary and malar bones consists of closely placed shallow fossæ. On the posterior part of the frontals there are strong ridges radiating posteriorly, and situated close together.

Measurements.	M.
Length of skull to end of angle of lower jaw	.090
" " frontoparietal fontanelle	.056
" " orbit, above	.026
" ramus mandibuli	.082
Depth of skull at orbit	.033
" ramus "	.019
Width of skull posteriorly	.068
" " between orbits	.017
" " between external nares	.0105
Diameter of first premaxillary tooth	.003
" second maxillary tooth	.003
Six fossæ of the malar bone	.005
Seven grooves of the frontal bone	.005

This species is much larger than the *Ectocynodon ordinatus* Cope, and the canine tooth has a more anterior position.

Discovered by W. F. Cummins.

DIPLOCAULUS Cope.

Paleontological Bulletin No. 26. p. 187, Nov. 21st, 1877. Proceedings American Philos. Society, 1877, p. 187.

This genus was characterized by me at the places cited, as follows: "Vertebral centra elongate, contracted medially, and perforated by the

foramen chordæ dorsalis, coössified with the neural arch, and supporting transverse processes. Two rib articulations, one below the other, generally both at the extremities of processes, but the inferior sometimes sessile. No neural spine nor diapophysis ; the zygapophysis normal and well developed."

This diagnosis was derived from the vertebræ of a single species from the Clepsydrops shale of Illinois, the *D. salamandroides*, and since that description was written, no additional specimens have come under my observation. In the Catalogue of the Vertebrata of the Permian I placed the genus as the type of a family, the *Diplocaulidæ*, among the Pelycosauria. I am now, however, through the energy of Mr. W. F. Cummins, in possession of specimens of a number of individuals of a second species of *Diplocaulus*, found by him in the Permian beds of Texas. From them I derive that the genus and family must be referred to the Stegocephalous Batrachia. It is, however, exceptional among these in the fauna of which it is a member, in not belonging either to the Rhachitomi* or to the Embolomera, since the vertebral centra are not segmented, nor are the intercentra present in any form. Under these definitions it must be referred to the suborder which includes *Oëstocephalus, Ceraterpeton*, etc., for which I have adopted Dawson's name Microsauria. The division includes genera with simple amphicœlous vertebral centra, and teeth without inflections of the dentine. The following characters must be added to *Diplocaulus* :

Vertebræ with a more or less perfect zygosphen articulation ; centra shorter in the anterior than in the median part of the column ; axis and atlas solidly united by a long zygosphen, which is not roofed over by the zygantrum. Neural arch continued as a short tube into the foramen magnum. Atlas unsegmented, and, like the axis, without free hypapophysis. Cervical vertebræ not distinguished from dorsals, and with two-headed ribs.

Orbit separated from the maxillary bone by the union of the lachrymal and malar. Either the malar, or more probably the quadratojugal, extends much posterior to the quadrate bone. It is bounded above by the squamosal, which extends anteriorly to the distinct postfrontal, thus covering over the temporal fossa. Posteriorly it extends into a long, free process, like the operculum of *Polyodon* ossified. This horn does not appear to consist of the epiotic as appears to be the case in *Ceraterpteon*. The quadrate bone is extended very obliquely forwards and its extremity is divided into an hourglass-shaped condyle. In other words the condyle consists of two cones with apices continuous. The internal cone is the smaller, and its base is overlapped from before by a flat bone, probably the pterygoid. The cotyli of the mandible correspond. Mandible without angle ; symphysis short.

The teeth are of about equal size, and are rather slender and with conical apex. Their surface is not inflected at any point. The superior series is

* American Naturalist, 1882, p. 334.

double, forming two lines between which the mandibular teeth close. This superior series stands near the external edge of the vomer, palatine and pterygoid bones successively. I have not been able to find any larger teeth in the jaws in this genus. Some fragments mingled with those here described, display such teeth, but I think they pertain to a species of another genus. I know nothing of the limbs of this genus.

Diplocaulus magnicornis, sp. nov.

The species is indicated by fragments of a number of crania, and portions of several vertebral columns. These were collected at two different localities by Mr. W. F. Cummins.

The skull is very peculiar in the great extent of the parts posterior to the orbits as compared with the portion anterior to them. The posterior border not being complete, the proportions cannot be exactly given, but the part anterior to the orbits is two-thirds the length of the part extending from their posterior border to near the base of the lateral horn, and one-fifth the distance from the orbit to the extremity of the horn. The part of the border of the orbit preserved indicates that the latter is of fair size. It is separated from the maxillary border by at least its own diameter. The external nares are peculiarly situated. They are nearer the orbit than the end of the muzzle, and are close to the maxillary border, being separated from the mouth by a narrow strip of bone only. They are round, open nearly laterally, and are removed from the edge of the orbits by the diameter of the latter.

The malar or quadratojugal bone is protuberant at the canthus oris and projects laterally beyond the mandible at its posterior part. It also projects beyond the extremity of the quadrate bone. This border is continued as that of the external base of the horn, but the portion which belongs to this element is soon distinguished from the superior element (squamosal) which composes the horn, by a groove. This groove is decurved, and bounds the apex of the element, which is a decurved, low tuberosity[t] The horn is produced backwards in a horizontal plane, forming a long fla triangle which contracts gradually with straight sides. The apex is narrowed, obtuse, and a little incurved. Near and at the extremity the horn is flat above and convex below.

The mandibular quadrate cotylus consists of two fossæ, which together form an approximate figure ∞, of which the internal fossa is the smaller, and opens internally. The external one is nearly transverse. The superior border of the ramus posteriorly is straight. The greater part of the superior aspect is occupied by a huge fossa which opens upwards.

It is uncertain whether the horns meet at an entering angle on the middle line posteriorly or not, but the width of the base of the horn indicates that such is the case. The extremity of the muzzle is depressed, and is broadly rounded.

The external surface of the skull is sculptured in the form of fossæ so distributed that the narrow ridges separating them do not form straight

lines, except in a few places on the superior face of the horn. This sculpture is strongly impressed, and is of medium coarseness. It extends on the inferior face of the quadratojugal (?) posterior to the quadrate, and on the inferior side of the horn at the edges. It is most extended below from the interior edge, and for the terminal inch of the horn, is as well marked as on the superior face. Elsewhere the sculpture of the inferior side passes into punctæ before disappearing. A groove marks the superior boundary of the maxillary bone, which divides when it reaches the superior surface. One branch descends behind the nostril, the other passes transversely across the lachrymal bone and shallows out before reaching the middle line of the muzzle. The mandible is even rougher than the superior surfaces, and has a longitudinal groove below the dental line, to near the symphysis, where it runs out on the alveolar edge. The internal and external sides of the mandible posteriorly, are smooth. On the malar and other facial bones there are four fossæ in 9 or 10 mm.

The atlas is peculiarly flattened above, the neural arch being a tube, without neural spine. Its anterior tubular prolongation is not long, and is deeply notched below. The condyloid fossæ are widely spread transversely and nearly flat, except that their surface is carried forwards on the neural tube. They are well separated below. There is a strong hypapophysial keel, which diminishes and runs out anteriorly. There are prezygapophysial facets, but the postzygapophyses exist. Their superior edge is however carried posteriorly to form the sides of the huge embracing zygantrum. These side processes, which I will call zygantropophyses, extend as far posteriorly as above the posterior end of the centrum of the axis, embracing almost the whole of the neural arch. There is another short median superior process, which notches the extremity of the zygosphen. The side of the atlas between the postzygapophysis and the condyloid facet is wrinkled, and the inferior face finely punctate.

In the axis, the hypopophysis is a large ridge with a horizontal truncate edge. The costal heads of the diapophysis are not split to the base of the latter and the superior is the more robust (extremities broken off). Centrum concave posteriorly, and on each side of hypopophysis with reticulate surface. A short zygantropophysis; zygantrum not large. Exposed summit of zygosphen (nearly equal neural arch) without neural spine. In both the axis and other cervical vertebræ, the superior diapophysis is connected with the zygapophyses fore and aft, in accord with the shortness of the centra. In the more posterior vertebræ they become separated on account of the increasing length of the centrum.

The third vertebra is like the axis, except in having a keel-shaped neural spine, and a short obtuse zygosphen continued from its base anteriorly. With increasing length of centrum the diapophysis becomes longer, and the hypapophysial ridge becomes wider, and coëxtensive with the inferior face of the centrum. It is separated by an angle from the sides in the longer vertebræ; in those of intermediate length, the inferior face is

convex. All of them retain the delicate lines and punctæ of the inferior surface. The neural spine on the more elongate vertebræ is a rather elevated keel, with horizontal superior edge. Its posterior extremity forms a wedge-like zygosphen. The zygantrum is a deep V-shaped cavity, opening posteriorly and not roofed over at any point unless for a small part of its fundus. The zygapophyses are well spread, and have horizontal faces. Each of the columns of the diapophysis sends a ridge forwards, which enclose a groove between them.

Measurements of vertebræ.

		M.
Length of atlas below		.015
" " at zygantropophyses		.029
Expanse " " condyloid facets		.034
" of centrum atlas behind		.0145
Depth of atlas at middle		.019
Length of axis below		.015
" " at zygantropophyses		.016
Width of zygosphen above		.011
Expanse of postzygapophyses		.024
Width of centrum posteriorly		.012
Depth " "		
Length of centrum of another (No. III)		.018
" " " (No. IV)		.022
Expanse of postzygapophyses of do		.018
Length of centrum of No. V		.022
Diameters centrum V anteriorly	vertical	.013
	transverse	.012
Expanse prezygapophyses		.021
Elevation of neural spine from centrum		.011
Diameters centrum No. VI	anteroposterior	.023
	vertical	.011
	transverse	.013

The vertebræ of this species are very much larger than those of the *D. salamandroides*, and the diapophyses do not originate so low down on the centrum. Otherwise they are much alike. The cranium of the Illinois species is yet undetermined.

The *D. magnicornis* was discovered by W. F. Cummins.

ACHELOMA. Cope, genus novum.

Order Rhachitomi ; family Eryopidæ,* differing from *Eryops* in the absence of notch of the posterior border of the skull between the epiotic and quadrate or squamosal bones, and in the absence of condyles of the humerus.

Mandible without angular process. Teeth of the jaws subequal, rather larger anteriorly ; some large ones on the *os palatinum* at different points

* American Naturalist, 1882, p. 335.

along the external margin. Pterygoid bone ending in a free decurved edge anterior to the quadrate bone. Palatines and pterygoids narrow, leaving a wide palatal foramen. Vertebræ in their principal features as in *Eryops*. The humerus is unlike any of those enumerated in my synopsis of Permian humeri,* but resembles the one figured by Gaudry as belonging to *Actinodon*, except that in *Acheloma* there are no condyles, and there is an epicondylar foramen. This is the first time I have observed the foramen in a Batrachian, though it is universal, so far as known, in the Pelycosauria. As in *Actinodon*, there is a short process above the external epicondylar angle.

The absence of humeral condyles in this genus is paralleled by the same feature in *Clepsydrops natalis*. It looks as though the animal were young, and had not yet attained to the coössification of epiphyses. This theory may account for the condition of the humeri in the two species mentioned. It occurs equally in the *Trimerorhachis insignis*. As all these species show every other indication of maturity, and as I have never yet observed free epiphyses in any of my numerous Texan collections, I am disposed to look on this condition of the humeri as a case of permanent incompleteness, of which the Batrachia present so many instances.

ACHELOMA CUMMINSI, sp. nov.

This animal is represented by a greater part of a skull and vertebral column, with both humeri and scapulæ and various other bones of the limbs, including phalanges. All of these remains look a good deal like *Eryops megacephalus*, and they might be supposed on hasty examination to belong to the young of that species. On a full investigation the following differences appear, besides those already mentioned in the generic diagnosis.

The muzzle is relatively much shorter, and the extremity is less depressed; the length from the supraöccipital forwards, is a little less than the total width at the same point. In agreement with this, the mandibular rami, after diverging strongly from the symphysis, are strongly incurved to the quadrate, a form not found in *E. megacephalus*. The sculpture is more sharply defined in the present species. In the vertebræ, although the intercentra have the same degree of ossification as in the *E. megacephalus*, the neural spines have not the expanded head of those of the larger species, but look as though they had lost an epiphysis, as in the case of the humeri. They are erect, with subquadrate section, and not oblique and grooved as *Trimerorhachis insignis*. The diapophyses are more elongate than in *E. megacephalus*, and their extremities frequently have a subround or suboval section, and but few have the narrow surface seen in *E. megacephalus*. The ribs are short and flat, and have the distal extremities expanded paddle-shape. Laid backwards such a rib reaches to the posterior edge of the third diapophysis posterior to the one to which it is attached.

* Proceedings American Philos. Soc., 1878, p. 528.

The form of the skull is triangular, with rounded apex or muzzle, and a slight contraction behind the nostrils. The latter are near the edge of the jaw and open equally laterally and superiorly. The orbits are of medium size, and are as far from the edge of the jaw as the width of the interorbital space, which is about as wide as the diameter of an orbit. The posterior "table" is flat with decurved lateral edges, which rest in a squamosal suture on the squamosal or quadratojugal and quadrate bones. Its posterior angle is produced downwards and backwards to near the distal extremity of the quadrate. The latter slopes posteriorly and downwards. The quatratojugal region is strongly convex in vertical section. The mandibular ramus is strongly incurved posteriorly, from a point opposite the free extremity of the pterygoid. The symphysis mandibuli is short.

The sculpture is distinct on all the superior surfaces of the skull, and consists of fossæ of medium size, bounded by irregular narrow ridges. There are three fossæ in 10 mm. The fossæ are obsolete on the extremity of the muzzle and on the anterior part of both jaws.

The teeth are a little longer on the premaxillary than on the maxillary bone. There are five on each, or six, if the tooth below the nostril belongs to the premaxillary bone, The palatine teeth are much larger. The first, perhaps standing on the external edge of the vomer, is a little posterior to the line of the external nostril. The second is half way between the nostril and orbit, and the third is alongside of and just posterior to it. The fourth is opposite a point a little posterior to the middle of the orbit. Their surface is as yet obscured by a thin layer of fine indurated mud, which in some instances cannot be removed without destruction of the tooth surface.

The intercentra of the vertebræ are, as in *Eryops megacephalus*, ossified so as to nearly cut off the chorda dorsalis, but unlike that species they are not notched on one side of their lateral apices. The extremities of the neural spines are subquadrate, rounded behind, and flattened anteriorly. The edges of the postzygapophyses are prominent and flared upwards.

The scapula is robust and flat, having the posterior-external border longest, and concave, and the superior-posterior, convex. In my specimens the thin anterior edge is broken. The coracoid appears to be coössified with the proximal external edge of the scapula, and is directed downwards and backwards. Its extension is small, and terminates in an apex posteriorly, and a thick double edge inferiorly. The glenoid cavity borders this edge, and is small. The epicoracoid if it existed, is lost. The thick inferior edge of the coracoid and scapula, is similar to those of the humerus and vertebral processes, which suggest a cartilaginous cap. The position of the scapula and coracoid is peculiar. If the glenoid cavity is directed outwards, the ribs adherent to them fit their extremities, from which they have been broken, which adhere to the vertebræ. This is probably the natural position. When thus placed, the plate of the scapula is horizontal transversely, and inclined upwards and posteriorly at 30°. The coracoid

is vertical. When in place, there is a large tuberosity above and anterior to the glenoid fossa, immediately behind which is a wide shallow fossa.

The curve of the proximal extremity of the humerus is a semicircle. That of the distal end is less convex, being flattened at the middle. Viewed proximally the proximal end is a little concave on one side, and one extremity of the articular surface is expanded and rounded. Viewed distally, the distal extremity is angulate concave, the middle portion being straight and the extremities bent in the same direction, one being longer than the other, and neither expanded. The entire extremity makes an angle of 90° with the plane of the proximal end. The epitrochlear foramen is protected by a strong bridge.

Measurements.

Skull.	M.
Length to line of angles of mandible	.188
" posterior edge of supraöccipital	.168
" line of posterior edge of orbit	.121
" " anterior edge nares	.017
" " extremity of pterygoid	.142
Width of skull at angles of mandible	.134
" " , greatest	.158
" " just behind nares	.051
" " at nares	.054
" of cranial table at middle	.086
" between orbits	.030
Length of a premaxillary tooth	.011
Diameter of base of do	.004
Length of a median maxillary tooth	.007
Diameter of base of do	.004
Length of a median palatine tooth	.021
Diameter of same at base	.009
Depth of ramus mandibuli at angle	.015

Vertebræ and Ribs.

Diameters of intercentrum { transverse	.018
Diameters of intercentrum { antroposterior	.010
Total elevation of same vertebra	.027
Elevation of neural spine above postzygapophysis	.005
Total expanse of diapophyses of same	.027
Length of diapophysis from postzygapophysis	.0095
Diameter of end of { neural spine	.206
Diameter of end of { diapophysis { transverse	.004
Diameter of end of { diapophysis { vertical	.006
Length of rib of 5th vertebra in advance of the vertebra measured	.038
Width of rib distally	.027

Scapular arch.

	M.
Length of scapula on anterior face	.069
Width do. at antero-internal distal angle, transversely	.032
" of coracoid and epicoracoid at glenoid cavity, from edge of scapula	.023
Length of epicoracoid and coracoid	.037
" humerus	.064
Width of shaft at middle	.016
Diameters proximal end { long	.039
Diameters proximal end { short at middle	.010
Diameters distal end { long	.039
Diameters distal end { short at middle	.010
Length ungual phalange	.004
" second "	.0075
" first "	.0135
Width do. { proximally	.010
Width do. { distally	.008

This species was discovered by Mr. W. F. Cummins, to whom I dedicate it with much pleasure.

ANISODEXIS Cope, genus novum.

Class Batrachia; order Rhachitomi; family Eryopidæ. Teeth on premaxillary, maxillary, and dentary bones of unequal lengths, some very large, others very small. Dentinal inflections straight, nearly reaching the pulp cavity. Cranial surfaces sculptured.

This genus differs from all the others of the *Eryopidæ,* in the great and abrupt inequality of the teeth of the external series of the mouth, resembling in this respect some of the Saurians of this deposit, rather than the batrachia. Whether it possesses long palatine or pterygoid teeth such as most of the latter exhibit, is not rendered clear by the specimens, but appearances indicate the presence of one near the anterior part of the maxillary. Mandibular series simple.

ANISODEXIS IMBRICARIUS Cope, sp. nov.

Founded on numerous fragments of the skull with jaws, and a vertebral arch and spine found in connection with the remains of the *Diplocaulus magnicornis.* These pieces indicate a larger species than the latter, and are nearly equal to the *Eryops megacephalus.* The jaws are not preserved entire, but portions from different parts of the length display the dental characters.

The sculpture of such parts of the superior surface of the skull is a coarse reticulation, coarser than in any other species known to me. Near the edges, some of the bones become smoother, and the ridges flatten into overlapping laminæ. The entire sculpture of the dentary bone is of this imbricate character, the apparent overlapping being from before back-

wards, and below upwards. This is totally different from what is observed in the other known species of *Eryopidæ, Trimerorhachidæ*, and *Diplocaulidæ*. The teeth are round in section, but become lenticular near the apex, developing low cutting edges. The basal grooves are fine, but distinct, and extend half way to the apex, or farther. One large, and one medium sized teeth stand on each dentary bone near the symphysis, and there are two similar ones at a point further back on the same bone. Near the anterior part of the maxillary, below the ? nostrils, is a huge tooth, with a graduated series of small teeth posterior to it, and a very small one anterior to it.

The neural arch of a vertebra has a well developed vertical spine. Its neurapophysis rested in an oval fossa of the centrum which probably was divided into pleurocentra. The prezygapophyses are very small, and look directly upwards. The postzygapophyses are much larger, and look obliquely outwards and backwards. The spine is not expanded at the summit, and is granular, as though it was protected by a cartilaginous cap. Its section is anteroposteriorly lenticular, with acute edge (angle) posteriorly, and a very narrow truncate edge anteriorly. The latter is bounded below just above the root of the neural arch by two little fossæ. The posterior keel is bounded below by a corresponding single fossa. The posterior acute edge of the spine is dentate, and the surface on each side of it, is beveled with rabbeted surfaces as though for a coarse squamosal suture. But the appearance of suture is fallacious, and is simply due to contraction of the transverse diameter of the spine. The neurapophysis is much narrower anteroposteriorly than the neural spine.

Measurements.	M.
Depth of maxillary bone at large anterior tooth	.037
" dentary at symphysis	.025
" " near middle	.021
Width " " "	.015
Diameter of base of large maxillary tooth	.010
" " small maxillary tooth	.0035
Length " " " "	.008
" of large mandibular tooth near symphysis	.016
Diameter of base of crown of do	.006
Elevation of neural arch	.037
Diameters neural spine { vertical	.029
Diameters neural spine { at apex { anteroposterior	.019
Diameters neural spine { at apex { transverse	.012
Width neurapophysis anteroposteriorly	.010

From Mr. W. F. Cummins' collections.

I had thought at one time that this species might be referable to the genus *Leptophractus* of the Coal Measures. No trace of the vertebræ of the Rhachitomous order has yet been found in that formation in this country, nor have any of the Coal Measure genera of Batrachia yet been found in

the Permian of the United States.* It is not improbable that such occurrence of genera may yet be substantiated, but the identification of an order hitherto unknown in a formation, on uncertain characters, is not a safe proceeding. The vertebræ of *Leptophractus* although not certainly known, are supposed to be of the Labyrinthodont type. The teeth are much more compressed and trenchant than in the present species, nor do there appear to be any long ones near the symphysis mandibuli. I consider the question of reference to Leptophractus to be still an open one.

The family *Eryopidæ*, though abundant in individuals, is not represented by many species. They are presumably as follows:

Anisodexis imbricarius Cope.
Acheloma cumminsi Cope.
Eryops reticulatus Cope.
Eryops ferricolus Cope (*Parioxys olim*).
Eryops megacephalus Cope.
Actinodon frossardi Gaudry.
Zatrachys serratus Cope.
Zatrachys apicalis Cope.

But the occipital condyles are unknown in *Acheloma* and *Zatrachys*.

I may add here that through the courtesy of Messrs. Scott and Osborne, I have seen, in the Museum of Princeton College, vertebræ of some species of the Rhachitomi from Saarbrücken, along with *Archegosaurus*, with entire centra, from the same locality.

Synopsis of the Vertebrata of the Puerco Eocene epoch. By E. D. Cope.

(Read before the American Philosophical Society, October 20, 1882.)

REPTILIA.

CROCODILIA.

Crocodilus sp.
Crocodilus sp.
Crocodilus sp.

TESTUDINATA.

Plastomenus ? communis Cope.
Dermatemys sp.
Compsemys sp.
Emys sp.

* *Peplorhina arctata* Cope, from the Illinois Permian is not a *Peplorhina*, but a Theromorph Saurian.

CHORISTODERA.

Champsosaurus australis Cope, American Naturalist, 1881, p. 690.

Champsosaurus puercensis Cope, Proceedings American Philosophical Society, 1881, p. 195.

Champsosaurus saponensis Cope, Loc. cit. 1881, p. 196.

MAMMALIA.

MARSUPIALIA.

Ptilodus mediaevus Cope, American Naturalist, 1881, p. 922.
Ptilodus trovessartianus Cope, loc. cit. 1882, p. 686.
Catopsalis foliatus Cope, loc. cit. 1882, p. 416.
Catopsalis pollux Cope, loc. cit. 1882, p. 685.
Polymastodon taöensis Cope, loc. cit. 1882, p. 684.

BUNOTHERIA.

Taeniodonta.

Hemiganus vultuosus Cope, loc. cit. 1882, p. 831.
Tæniolabis scalper Cope, loc. cit. 1882, p. 604.

Tillodonta.

Psittacotherium multifragum Cope, l. c., 1882 p. 156.

Psittacotherium aspasiæ Cope, Proceed. Amer. Philosophical Society, 1882, p. 192, (1882).

Mesodonta.

Pelycodus pelvidens Cope, Proceeds. Amer. Philos. Soc. 1881, (1882) p. 151. *Lipodectes pelvidens* Cope, American Naturalist. 1881, p. 1019.

Hyopsodus acolytus Cope, sp. nov.

This the least species of the genus, is also the oldest, being derived from the Puerco horizon. Parts of two individuals furnish the characters of the inferior and superior true molars, and the fourth superior premolars. The species differs from those hitherto described in other characters than the minute size. One of these is the absence of posterior interior cusp, the heels of the first and second true inferior molars being bounded by a ridge only at this point, as in most of the species of *Pelycodus*. The last inferior molar is not smaller than the second, nor longer. The anterior cusps of all the molars are robust, so that on the first and second true molars they are separated by a shallow notch only. There is a rudiment of the anterior inner cusp on the first true molar but none on the second and third. The posterior external is obtuse and has a triangular section on all the molars; a crest is continued from the heel of the third molar on the inner side of the crown half way to the anterior inner cusp.

The *Microsyops spierianus* differs from this species in its smaller size (true molars .008) and in the presence of posterior internal cusps of the true molars.

The *Hyopsodus acolytus* was found by Mr. D. Baldwin, in New Mexico.

CREODONTA.

Sarcothraustes antiquus Cope, Proceeds. Amer. Philos. Soc. 1881 (1882), p. 193.

Dissacus carnifex Cope, Amer. Natst. Oct. 1882 (Sept.), p. 834.

Dissacus navajovius Cope, loc. cit. 1881, p. 1019. *Mesonyx navajovius* Cope, Proceeds. Amer. Philos. Society, 1881, p. 484.

Triisodon quivirensis Cope Amer. Nat. 1881, p. 667.

Triisodon heilprinianus Cope, Proceeds. Amer. Philos. Soc. 1881 (1882), p. 193.

Deltatherium fundaminis Cope, Amer. Nat. 1881, p. 237; 1881, p. 337. *Lipodectes penetrans*, loc. cit. 1881, p. 1019.

Deltatherium baldwini Cope.

This Creodont is known only from a portion of a right mandibular ramus which supports the two last premolars, and the first true molar with part of the second. It differs from the *D. fundaminis* in its materially smaller size, and in the forms of the teeth. The first true molar is a more robust tooth, and the basis of the posterior or heel crest is more rounded, and less angulate. The anterior inner cusp projects less anteriorly. The fourth premolar has a distinct anterior basal lobe which is wanting in the *D. fundaminis*. Its heel is short and wide, and the posterior face of the principal cusp is flat, and there is a rudiment of an internal tubercle on its side. The second premolar is elevated and acute, has no anterior basal lobe, and has a very short wide heel, enamel slightly roughened. The animal was rather aged.

Measurements.		M.
Length of P-m. ii and iii and M. ii		.0160
Diameters M. i	anteroposterior	.0058
	transverse	.0040
Elevation of crown of P-m. iii		.0052
Depth of mandible at M. i		.0180

From the Puerco beds of N. W. New Mexico. Dedicated to Mr. D. Baldwin, the discoverer of the Mammalian Fauna of the Puerco beds, which is one of the most important in the history of American Palæontology.

Deltatherium interruptum Cope.

The smallest species of *Deltatherium* is, like the *D. baldwini*, only represented by the anterior part of a right mandibular ramus, which supports the last premolar and the first true molar, with the bases of the other pre-

molars and part of the canine. The canine is small and the first premolar in accordance with the generic character, is wanting. The second premolar is two-rooted. The fourth has an elevated principal cusp, and a narrow heel on the inner side of the posterior base; anterior base injured. The first true molar has very little sectorial character, and resembles the corresponding tooth of a *Pelycodus*. It differs entirely from that of the *D. fundaminis* in the possession of a well marked posterior internal cusp, which is connected by a ridge with the large internal lateral cusp of the heel. The anterior cusps of opposite sides sub-equal. A weak external basal cingulum on the anterior half of the crown; no internal cingulum. Enamel of the tooth wrinkled.

Measurements.		M.
Length of premolar series		.0140
Elevation of P-m. iv		.0040
Diameters of M. i	antero posterior	.0055
	transverse	.0042
Depth of Ramus at P-m. i		.0090
" " M.		.0113

On comparison with the *D. fundaminis*, the first molar tooth has the same dimensions, but the premolars are considerably smaller. The ramus is also shallower. Found by Mr. Baldwin in the Puerco beds of Northwest New Mexico.

Didymictis haydenianus, sp. nov.

This creodont is represented by parts of the maxillary and mandibular bones of the left side, the former supporting the four, and the latter supporting the three last molars. The arrangement of the superior molars is much as in *D. protenus*, the fourth premolar being a true sectorial. The third premolar has no internal lobe, although the section of the base of the crown is narrowly triangular. It has anterior and posterior basal lobes, and a posterior lobe on the cutting edge. In the sectorial the median lobe is a good deal more produced than the posterior, though the two form together the usual blade. The anterior basal lobe is distinct; and the internal is larger and is conic. The first true molar has the anterior external base of the crown produced. Its two external cusps are conic and distinct. The internal part of the crown is rounded and supports a conic internal tubercle, which is separated from the external cones by two small concentric tubercles. The second true molar is considerably smaller, and is transverse, its external border being very oblique. It has an acute internal lobe.

The character of the species is well-marked in the inferior true molars. The first has the form seen in other species of *Didymictis*. The heel is large, and with a median basin between lateral cutting edges. The two anterior inner cusps are of equal elevation and are near together; the external is much larger. The last molar is elongate, but reduced in size. Its anterior three cusps, rudimental in other species, are here elevated, forming the triangular mass seen in the first true molar. They are not so

elevated, however, as in that tooth, and thus not so much developed as in *Oxyœna*, *Stypolophus*, etc. The fourth premolar has a median cutting edge on the short heel.

Measurements.		M.
Length last four superior molars		.022
" P-m. iii		.0065
" " iv		.0085
Width " "		.0050
Diameters M. i	anteroposterior	.0055
	transverse	.0088
	oblique external	.0072
Diameters M. ii	anteroposterior	.0027
	transverse	.0055
Diameters inferior M. I	anteroposterior	.007
	transverse	.005
Diameters inferior M. II	anteroposterior	.0055
	transverse	.003
Depth of ramus at M. II, (squeezed)		.010

The peculiar characters of the last inferior molar distinguish this species from its congeners. The last superior molar is relatively smaller than in the *D. protenus*. In size this species is superior to the *D. dawkinsianus*, and is smaller than the *D. leptomylus*. It is dedicated to the distinguished geologist Dr. F. V. Hayden.

New Mexico, D. Baldwin.

TAXEOPODA.

Condylarthra.

Periptychidæ.

Periptychus rhabdodon Cope. *Catathlœus rhabdodon*, American Naturalist, 1881, 829.

Periptychus carinidens Cope, loc. cit. 1881, p. 337.

Periptychus ditrigonus Cope, sp. nov.

This rare species is known from a right mandibular ramus, which exhibits part of the symphyseal suture, with the alveoli of the molar teeth, except the first. The only well preserved crown is that of the second true molar.

The second true molar presents very peculiar characters, and the mandibular ramus is shallower and thicker than in the two other species of *Periptychus*. The former has a wide external cingulum which is not present in the other species, and there are only six cusps instead of seven. These are peculiarly arranged. The anterior three are much as in *P. rhabdodon*, the anterior being not quite so far internal as the posterior inner, close to it, and as large as the anterior external. The posterior three, are a posterior inner and posterior median as in *P. rhabdodon*, and a peculiarly placed posterior external. This is not

opposite the posterior inner, but is anterior to such a position and intermediate between the latter point, and the one occupied by the median tubercle in *P. rhabdodon*. It is as large as the anterior external tubercle. All these tubercles are conical, and not connected by angles or ridges. The posterior external cusp leaves the cingulum wide posteriorly, and its edge develops some small tubercles. There are also some small tubercles at other points on the edge of the crown, but no other cingula. The enamel is not regularly ridged as in *P. rhabdodon*, but has a rather coarse obsolete wrinkling.

Measurements.		M.
Length from P-m. ii to M ii inclusive		.052
Diameters of M. ii	anteroposterior	.011
	transverse	.010
Depth of ramus at M. ii		.022
Width of " "		.016
Depth of " " P-m. ii		.019

From the Puerco formation of New Mexico, D. Baldwin, discoverer.

Haploconus lineatus Cope, Amer. Nat. 1882, p. 417.

Haploconus angustus Cope, Loc. cit. 1882, p. 418. *Mioclænus angustus* Cope, loc. cit. 1881, p. 831.

Haploconus xiphodon, sp. nov.

This species is represented by a mandibular ramus, and perhaps by three rami. The one on which the species rests contains five molars, the middle one of the series broken, so that its form cannot be positively ascertained. It is probable that it is the first true molar, so that the animal exhibits the last true molar not entirely protruded, and is therefore nearly adult, but there are some reasons for suspecting it to be young. Thus the last inferior molar does not exhibit more of a heel than the second usually does, and the third supposed premolar is smaller than that tooth is in the other species, having nearly the proportions of the second premolar. The teeth present may then be supposed to be the molars from the second to the sixth inclusive. But opposed to this view is the fact that the supposed third premolar has more the structure of that tooth in details, than that of the second, and the specimens accompanying, which have the temporary dentition apparently of the same species, present premolar teeth of a very different character. In any case the present specimen represents a third species of the genus, and I describe it at present as an adult.

The third premolar has a simple compressed crown, about as high as the length of its base, and without anterior basal tubercle. It has a narrow triangular posterior face which is concave, and truncated by a cingulum below; no heel proper, nor lateral cingula. The fourth premolar is an elongate tooth consisting of a compressed principal median lobe, an anterior lobe connected with it, and a heel. The latter has elevated posterior and interior borders. A rudiment of an exterior border is seen in a narrow

ridge on the external side of the posterior face of the principal lobe of the tooth.

The sides of the premolars present rather distinct ridges, as in *Periptychus carinidens*. The second true molar has two anterior and three posterior tubercles; the latter close together, pointed and of about equal size. Of the anterior tubercles, the external is much the larger and more elevated. It is compressed and has a curved subacute anterior edge, which extends much in front of the internal tubercle. There is no anterior inner tubercle, nor are there any cingula. The enamel of the sides of the crown presents a few vertical ridges. The last inferior molar only differs from the second, in the greater size of the median posterior lobe, which is nevertheless smaller than in the two other species of *Haploconus*.

There is a mental foramen below the posterior edge of the second inferior premolar.

Measurements.	M.
Length of last five inferior molars	.0250
" third premolar	.0050
" fourth premolar	.0066
" second true molar	.0050
Width of second true molar	.0032
Length of third true molar	.0050
Depth of ramus at P-m. iii	.0095
" " M. iii	.0130

The two rami with the temporary premolars, exhibit the last true molar enclosed in the jaw. The third and fourth premolars are much like the fourth premolar of the specimen above described, but the fourth is a little more robust than that of the latter, which is very much like the third of the deciduous series. The space occupied by the supposed first premolar of the type specimen is too short for the fourth premolar of the deciduous series, otherwise it might be supposed to have occupied that position. The two true molars resemble those of the type, excepting that the last one does not extend so far into the base of the coronoid process, and is in accordance with the position as number two in the series.

The specimens were procured by Mr. D. Baldwin in the Puerco beds of New Mexico.

Haploconus entoconus Cope, loc. cit. 1882, p. 686.

Anisonchus coniferus Cope, loc. cit. 1882, October (September), p. 832.

Anisonchus gillianus Cope. *Haploconus gillianus* Cope, loc. cit., 1882, p. 686.

Anisonchus sectorius Cope, Proc. Amer. Philos. Soc. 1881, p. 488, *Mioclaenus sectorius*, Amer. Nat. 1881, p. 831.

Hemithlæus kowalevskianus Cope, Amer. Nat. 1882, p. 832.

Hemithlæus opisthacus Cope. *Mioclænus opisthacus*, 1 c. 1882, p. 833.

Conoryctes comma Cope American Naturalist, 1881, p. 829.

Conoryctes crassicuspis Cope.

The posterior part of a mandibular ramus supporting the last two molar teeth indicates a second and larger species of the genus. The ramus is one-half deeper than that of the *C. comma*, and the second true molar is much larger than in that species. The last true molar is much smaller than the the penultimate, and consists of three anterior cusps and a longer heel. The former are obtuse, the external the longer, the internal equal, the anterior on the inner edge of the crown. The heel sustains a low conic tubercle.

From the Puerco beds of N. W. New Mexico.

Phenacodontidæ.

Protogonia plicifera Cope, Amer. Nat. 1882, Oct. (Sept.), p. 833.

Protogonia subquadrata Cope, Proceedings Amer. Philos. Soc. 1881, p. 492.

Phenacodus puercensis Cope, Proc. Amer. Philos. Soc. 1881, p. 492.

Phenacodus zuniënsis Cope, loc. cit. p. 492 ; loc. cit. 1881 (1882), p. 180.

Pantolambda bathmodon Cope, Amer. Nat. 1882, p. 418.

Mioclænus turgidus Cope, Amer. Nat. 1881, p. 830.

Mioclænus minimus, sp. nov.

This is one of the least mammalia of the Puerco fauna, exceeding by a little the *Hyopsodus acolytus*. It is represented by parts of two mandibles, which display all the true molars. As there are no premolars preserved, its reference to the genus *Mioclænus* is provisional only, but its true molars have the peculiar characteristics of those of the *M. turgidus*.

The two anterior cusps of the true molars are higher than the heel, and they are united together to a point above the level of the heel. The section of both those of the M. ii is round ; that of the external one of the first is cresentic ; of the inner cusp, round. The heel is wide, and supports a cusp at the posterior external angle. It is bounded posteriorly, and on the inner side by a raised ridge, which gives with the cusp, on wearing a comma-shaped surface. A transverse ridge closely appressed to the anterior cusps connects them anteriorly. In one of the specimens there is a cingulum on the external side of the second inferior molar ; on the other specimen it is wanting. Enamel smooth.

The mandibular ramus is rather deep and compressed, and displays an external ridge on the anterior border of the coronoid, which is not continued downwards.

Measurements (No. 2).		M.
Length of basis of true molars		.0125
Diameters M. ii	anteroposterior	.0040
	transverse	.0035
Depth of ramus at M. ii		.0073

From the Puerco beds of New Mexico. D. Baldwin.

Mioclænus subtrigonus Cope, Amer. Nat. 1881, p. 490, 491.

Mioclænus protogonioides Cope, loc. cit. 1882, Oct. (Sept.), p. 833.

Mioclænus mandibularis Cope, Amer. Nat. 1881, p. 830.

Mioclænus baldwini Cope, loc. cit. 1882, Oct. p. 833.

GENERAL REMARKS.

The preceding list of fifty-six species is doubtless sufficiently characteristic to enable us to form a pretty good idea of the Puerco fauna. Omitting six undetermined species of reptiles, we find the following peculiarities in the remaining forms. As already pointed out the three determined species of reptiles belong to a suborder, which has thus far been only found in the Laramie formation, or Cretaceous No. 6. This gives the Puerco at once a position below all the other tertiaries. The mutilate orders of mammals may be dismissed as being not likely to occur in a lacustrine formation. The orders of land Mammals are represented as follows :

Monotremata		0
Marsupialia		5
Rodentia		0
Chiroptera		0
Edentata		0
Bunotheria		15
Tæniodonta	2	
Tillodonta	2	
Insectivora	0	
Mesodonta	2	
Lemuroidea	0	
Creodonta	9	
Taxeopoda		25
Hyracoidea	0	
Condylarthra	25	
Proboscidea		0
Amblypoda		0
Diplarthra		0
Carnivora		0
Quadrumana		0
Total		45

The above list renders the peculiar facies of this fauna at once apparent. It is the only Tertiary fauna known, from which Perissodactyla are absent. The absence of Amblypoda, one of the oldest types, is unexpected. The lack of Rodentia is remarkable, and perhaps only due to failure of discovery ; but if yet to be found, they must be very rare, and their absence is consistent with their small representation in the Wasatch beds above them. In the large number of Bunotheria, the Puerco agrees with the later Eocenes, but the order is here characterized by the small number of Mesodonta ; and the Lemuroidea are apparently absent. An especial feature of the fauna is the presence of five undoubted species of Marsupialia of the family Plagianlacidae, which has its origin in the Jurassic

period, and extended through the Cretaceous. It is represented in the latter period in the Laramie by the genus *Meniscoëssus*.*

In the absence of a number of the existing orders of placental Mammalia, the Puerco agrees with other Eocene faunæ. In the absence of all of the placental orders with convoluted cerebral hemispheres, this fauna is more primitive than any other Eocene fauna. The absence of all ungulata excepting Taxeopoda, which have the most primitive foot structure, is further evidence of its primitive character. This is further increased by the presence of the Marsupialia above mentioned. The general result is a mixture of Marsupial, and semi-marsupial forms, with half lemurs, and a great expansion of the Hyracoid type.

In more detail, the genera of Bunotheria may be compared with those of the period immediately following; viz.: The Wasatch. One genus only of the Creodonta is common to the two epochs (*Didymictis*). Five of the species remaining are much like oppossums, and may be Marsupialia. The two genera (*Deltatherium* and *Triisodon*) to which they belong, do not occur in the Wasatch. The remaining two genera, (three species) are peculiar to the Puerco, but represent a family (Mesonychidæ) which occurs throughout our Eocenes. The two species of Mesodonta belong to genera of the Wasatch, one of them at least extending into the Bridger. The genera of Tæniodonta and Tillodonta are distinct from those of any of the later Eocenes, so far as known.

Supplement on a new Meniscotherium from the Wasatch epoch.

Meniscotherium tapiacitis, sp. nov.

The species now to be described is a good deal smaller than *M. chamense*, and, *a fortiori*, than the *M. terrærubræ*. It is known to me from the nearly entire rami of a single mandible. These support the last five molars of one side or the other, and alveoli of two others and of the canine tooth.

Two characters besides the small size, are observable in this jaw. First, the symphysis has not the shallow convex inferior outline in transverse section; but is on the contrary angular, having subvertical sides separate from a convex middle by a rounded angle. The symphysis is thus deeper than in *M. terrærubræ*. Second, the crown of the third inferior molar tooth has partly the form of that of the second of the *M. terrærubræ*. It is anteroposteriorly short, and has a short heel and no anterior basal lobe; the section of the principal lobe is lenticular, and profile subconic. In *M. terrærubræ* this tooth is elongate, with well developed heel and anterior lobe. The alveolus of the canine is relatively larger than that of the *M. terrærubræ*. The coronoid process does not rise so close to the last molar tooth, nor so steeply, as in the latter species. The posterior recurvature of the internal extremity of the anterior limb of the posterior V of the true molars is but little marked.

* American Naturalist, 1882, p 830, Sept, 28th.

Measurements.		M.
Length of true molars on base		.018
Diameters M. ii	anteroposterior	.006
	transverse	.0044
Diameters M. iii	anteroposterior	.0065
	transverse	.0038
Diameters P-m. iii	vertical	.0045
	arteroposterior	.004
Width of inferior face of symphysis		.008
Depth ramus at P-m. iii		.009
" " " M. iii		.0103

This species was obtained by Mr. D. Baldwin from beds of probably lowest Wasatch age, in New Mexico.

On the Systemaitc Relations of the Carnivora Fissipedia. By E. D. Cope.

(Read before the American Philosophical Society, October 20, 1882.)

This order embraces the clawed mammalia with transverse glenoid cavity of the squamosal bone, confluent scaphoid and lunar bones of the carpus, and well developed cerebral hemispheres. It is well distinguished from all others at present known, but such definition is likely to be invalidated by future discovery. Some of the Insectivora possess a united scapholunar bone, but the reduction of the cerebral hemispheres of such forms distinguishes them. The presence of the crucial fissure of the hemispheres is present under various modifications in all *Carnivora,* while the parietooccipital and calcarine fissures are absent.

The many types of existing carnivora fall into natural groups, which are of the grade termed family in zoölogy. But the distinction of these from each other is not easily accompanished, nor is it easy to express their relations in a satisfactory manner. The primary suborders of pinnipedia and fissipedia are easily defined. Various characters have been considered in ascertaining the taxonomy of the more numerous fissiped division. The characters of the teeth, especially the sectorials, are important, as is also the number of the digits. Turner* has added important characters derived from the foramina at the base of the skull, and the otic bulla, which Flower† has extended. Garrod‡ has pointed out the significance of the number of convolutions of the middle and posterior part of the hemispheres. I have added some characters derived from the foramina of the posterior and lateral walls of the skull.§ Mr. Turner also defines the families by the form and relations of the paroccipital process.

* Proceedings Zoological Soc., London, 1848, p. 63.

† Loc. cit., 1869, p. 5. ‡ Loc. cit., 1878, p. 377.

§ Proceedings Amer. Philosophical Society, 1880, p.

In studying the extinct carnivora of the Tertiary period, it has become necessary to examine into the above definitions, in order to determine the affinities of the numerous genera which have been discovered. To take them up in order, I begin with the foramina at the base of the skull. The result of my study of these has been, that their importance was not overrated by Mr. Turner, and that the divisions of secondary rank indicated by them are well founded. Secondly, as to the form and structure of the auditory bulla. Although the degree and form of inflation are characteristic of various groups of Carnivora, they cannot be used in a systematic sense, because like all characters of proportion merely, there is no way of expressing them in a tangible form. For, if the forms in question pass into each other, the gradations are *insensible*, and not sensible, as is the case with an organ composed of distinct parts. The same objection does not apply so much to the arrangement of the septa of the bulla. The septum is absent in the Arctoidea of Flower (*Ursidæ* of Turner), small in the Cynoidea (Flower, *Canidæ* Turner), and generally large in the Æluroidea (Flower, *Felidæ* Turner). But here occurs the serious discrepancy, that in the Hyænidæ, otherwise so nearly allied to the Felidæ, the septum of the bulla is wanting. Nevertheless, the serial arrangement of the order indicated by Flower, viz.: commencing with the Arctoidea, following with the Cynoidea, and ending with the Æluroidea, is generally sustained by the structure of the auditory bulla, and by the characters of the feet and dentition, as well as of the cranial foramina. Turner's arrangement in the order, Ursidæ, Felidæ and Canidæ, is not sustained by his own characters, and its only support is derived from Flower's observations on the external or sylvian convolution of the hemisphere of the brain.* There are three simple longitudinal convolutions in the raccoons; in the civets and cats the inferior convolution is fissured at the extremities, while in the dogs it is entirely divided, so that there are four longitudinal convolutions between the Sylvian and median fissures.

An important set of characters hitherto overlooked, confirms Flower's order. I refer to those derived from the turbinal bones. In the ursine and canine forms generally, the maxilloturbinal is largely developed, and excludes the two ethmoturbinals from the anterior nareal opening. In the Feline group, as arranged by Turner, the inferior ethmoturbinal is developed at the expense of the maxilloturbinal, and occupies a part of the anterior nareal opening. These modifications are not, so far as my experience has gone, subject to the exceptions seen in the development of the otic septa and molar teeth, while they coincide with their indications. The seals possess the character of the inferior group, or Ursidæ, in a high degree.

The characters derived from the paroccipital process are of limited application, as the study of the extinct forms shows.

* Proceedings Zoological Society, London, 1869, p. 482.

I would then divide the fissiped carnivora into two tribes as follows :

External nostril occupied by the complex maxilloturbinal bone ; ethmoturbinals confined to the posterior part of the nasal fossa ; the inferior ethmoturbinal of reduced size........................HYPOMYCTERI.
External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal...EPIMYCTERI.

While no doubt transitional forms will be discovered, the types at present known fall very distinctly into one or the other of these divisions. The characters are readily preceived on looking into the nares of well cleaned specimens. The *Hypomycteri* stand next to the *Pinnipedia,* since the maxilloturbinal bone has the same anterior development in that group.

In searching for definitions of the families, it is necessary to be precise as to the definition of terms. The meaning of the word sectorial is in this connection important, sinee there are so many transitional forms between the sectorial and tubercular tooth. A sectorial tooth then of the upper jaw, is one which has at least two external tubercles, which are the the homologues of the median and posterior lobes of the sectorial of the cat. By the flattening and emargination of their continuous edges, the sectorial blade is formed. One or two interior, and an anterior lobe, may or may not exist. In the genera of the *Procyonidæ,* except in *Bassaris,* the two external tubercles do not form a blade. The inferior sectorial tooth differs from the tubercular only in having an anterior lobe or cusp, which belongs primitively to the interior side. The inferior sectorial teeth with large heels, as in Viverridæ and Canidæ, I have called tubercular-sectorials. The sectorial blade is formed by the union and emargination of the edges of the anterior and the principal external cusp. This blade is not well developed in the genus *Cynogale* and still less in the *Procyonidæ* and *Ursidæ.* The families are then defined as follows.

HYPOMYCTERI.

I. No sectorial teeth in either jaw.

Toes 5–5..*Cercoleptidæ.*

II. Sectorial teeth in both jaws.

α. Toes 5–5

β. No alisphenoid canal.

True molars $\frac{2}{2}$..*Procyonidæ.*
" " $\frac{1}{2}$..*Mustelidæ.*

ββ. An alisphenoid canal.

Molars quadrate, $\frac{2}{2}$..*Aeluridæ.*
Molars longitudinal, $\frac{2}{3}$..*Ursidæ.*

αα. Toes 5–4 or 4–4.

Sectorials well developed, an alisphenoid canal..................*Canidæ.*

EPIMYCTERI.

I. Molars haplodont.

Toes 5-4; no alisphenoid canal.......................... *Protelidæ.*

II. Molars bunodont, no sectorials.

Toes 5-5; an alisphenoid canal.......................... *Arctictidæ.*

III. Molars bunodont, with sectorials.

α. Otic bulla with septum.

β. Alisphenoid canal and postglenoid foramen, present.

γ. True molars well developed.

Toes 5–5.......................... *Viverridæ.*

Toes 5–4.......................... *Cynictidæ.*

Toes 4–4.......................... *Suricatidæ.*

γγ. True molars much reduced.

Toes 5–5.......................... *Cryptoproctidæ.*

Toes 5–4.......................... *Nimravidæ.*

ββ. No alisphenoid canal; post glenoid foramen rudimental or wanting.

Toes 5–4.......................... *Felidæ.*

αα Otic bulla without septum.

No alisphenoid canal, nor post glenoid foramen: Toes 4–4...... *Hyænidæ.*

The genera of these families are the following:

CERCOLEPTIDÆ; *Cercoleptes* Neotropical.

PROCYONIDÆ; *Procyon,* Bassaricyon, Bassaris;* Neartic and Neotropical.

MUSTELIDÆ; Melinæ (two tubercles of internal side of superior sectorial); *Taxidea, Meles.* Mustelinæ, (one internal tubercle of superior sectorials); *Enhydris, Pteronura, Lutra, Aonyx, Barangia; Helictis, Zorilla, Mephitis, Conepatus; Mellivora; Gulo, Galictis, Putorius, Mustela.*

ÆLURIDÆ; *Aelurus; Æluropodæ? Hyænarctos.*

URSIDÆ; *Helarctos; Arctotherium; Ursus; Melursus.*

CANIDÆ; *Megalotis*†*; Amphicyon; Thous, Paleocyon, Temnocyon, Galecynus, Canis, Vulpes, Enhydrocyon, Hyænocyon, Tomarctus, Speothus, Synagodus, Dysodus, Oligobunis, Icticyon, Lycaon.*

PROTELIDÆ; *Proteles.* Ethiopian.

ARCTICTIDÆ; *Arctictis.* Indian.

VIVERRIDÆ; *Cynogale, Arctogale, Paguma, Paradoxurus, Nandinia, Hemigale, Galidia, Prionodon, Genetta Viverricula, Viverra, Galidictis, Herpestes, Athylax, Calogale, Ichneumia, Bdeogale, Urva, Tæniogale, Onychogale, Helogale, Rhinogale, Mungos, Crossarchus, Eupleres.*

CYNICTIDÆ; *Cynictis, ? Ictitherium.*

SURICATIDÆ; *Suricata;* Ethiopia.

CRYPTOPROCTIDÆ; *Proælurus; Cryptoprocta.*

NIMRAVIDÆ; *Archælurus, Nimravus; Ælurogale, Dinictis, Pogonodon; Hoplophoneus.*

* Including *Nasua,* which is not distinct.

† This genus cannot be made the type of a family as is done by Dr. Gray.

Felidæ ; Machærodontinæ ; *Machærodus, Smilodon ;* Felinæ ; *Plethælurus* (g. n.)*, *Catolynx ; Felis ; Neofelis ; Uncia,*† *Lynx, Cynælurus.*

Hyænidæ, *Hyænictis, Hyæna, Crocuta.*

* Type, *Felis planiceps* Temm. Char. Second (first) superior premolar two rooted; orbit closed behind; pupil round.

† Mr. Wortman has called my attention to a character of this genus which confirms its separation from Felis, as I proposed in 1879. The maxilloturbinal bone is less complex in the genus Uncia, than in Felis, consistently with a less nocturnal habit, and less necessity for acute smell.

Printed Nov. 11, 1882.

Paleontological Bulletin, No. 36.

FIRST ADDITION

TO THE

FAUNA OF THE PUERCO EOCENE.

(Read before the American Philosophical Society, January 5, 1883.)

ON THE

BRAINS

OF THE

EOCENE MAMMALIA PHENACODUS AND PERIPTYCHUS.

(Read before the American Philosophical Society, December 15, 1882.)

FOURTH CONTRIBUTION

TO THE

HISTORY OF THE PERMIAN FORMATION OF TEXAS.

(Read before the American Philosophical Society, March 16, 1883.)

By PROFESSOR E. D. COPE.

For Sale by A. E. Foote,

1223 BELMONT AVENUE, PHILADELPHIA.

First Addition to the Fauna of the Puerco Eocene. By E. D. Cope.

(Read before the American Philosophical Society, Jan. 5, 1883.)

There are fifty-five species included in my synopsis of the vertebrata of the Puerco epoch*. Ten of these are reptilia, the remainder mammalia. In the present paper a number of interesting additions are made. The typical specimens are figured in the fourth volume of the U. S. Geological Survey of the Territories, now in press.

Ophidia.

Helagras prisciformis, gen. et sp. nov.

Char. gen. The generic characters are drawn from vertebræ only. These display a modified form of the zygosphen articulation, as follows: The roof of the zygantrum is deeply notched on each side of the median line so as to expose the superior lateral angles of the zygosphen. This separate median portion of the roof of the zygantrum forms a wedge-shaped body which may be called the *episphen*, It is surmounted by a tuberosity, which constitutes the entire neural spine. The latter is thus entirely different in form from that of other serpents. Articular extremities of centrum round, the ball looking somewhat upwards. Costal articulation 8-shaped, the surfaces convex and continuous. Hypapophyses none on the two vertebræ preserved. Zygapophyses prominent. Free diapophyses none.

This genus is readily distinguished by the presence, now first observed, of the *episphen* in addition to the zygosphen; and by the peculiar form of the neural spine. We have now several vertebral articulations originally discovered in American vertebrata. These are the *episphen* as above, the *hyposphen*, which characterizes the Opisthocœlous Dinosauria (*Sauropoda* Marsh), and the *Diadectidæ* of the Permian period; and the *zygantrapophysis*, which is present in the Diplocaulid family of Batrachia.

Char. specif. A section of the vertebra at the middle is pentagonal, the inferior side slightly convex downwards. The lateral angle is the section of the angular ridge which connects the zygapophyses. The episphen has a shallow rounded groove on its infero-posterior side, which is bounded by a projecting angle on each side at its middle. The episphen does not project so far posteriorly as the postzygapophyses, and the degree of its prominence differs in different parts of the vertebral column. In one of the two vertebræ in my possession its prominence is small. The tuberosity on its summit is a truncate oval with the long diameter anteroposterior, and equaling two-fifths the length of the arch above. It is elevated above the rest of the median line, which is roof-like, with obtuse angle. The tubercular articular facet is entirely below the prezygapophyseal surface, but the free part of the prezygapophysis extends well in front of it. It is distinguished from the capitular surface by a very slight constriction. A slight ridge extends from the capitular articulation

* Paleontological Bulletin No. 35, Nov. 11th, 1882.

to the edge of the ball of the centrum. Below this the surface is slightly concave, and the middle line is gently convex. The latter terminates in an obtuse angled mark just in front of the edge of the ball. This edge is also slightly free from the ball. The capitular costal surfaces do not project inferiorly quite to the line of the inferior surface of the centrum.

Measurements of a Vertebra.	M.
Length of centrum (with ball)	.0070
Diameters of ball { vertical	.0035
Diameters of ball { transverse	.0040
Elevation of vertebra at episphen	.0085
" " middle	.0062
Width at prezygapophyses	.0120
" tubercular costal faces	.0105
" of zygantrum	.0058
Vertical diameter costal faces	.0040
Transverse diameter tubercular costal face	.0028

This snake was about the size of the black snake, *Bascanium constrictor*. It is an interesting species for two reasons. First, it is the oldest serpent known from North America. Second, in the imperfection of the zygantrum we observe an approximation to the ordinary reptilian type of vertebra, from which the ophidian type was no doubt derived. In the former there is no zygosphen or zygantrum.

Mammalia.

Triïsodon levisianus, sp nov.

This creodont is represented by part of a right mandibular raums which contains the fourth premolar minus its principal cusp, and the first and second true molars, with the alveoli of the third. The ramus is deep, and probably belonged to an animal of about the size of the red fox. The molars have the structure most like that of the *T. heilprinianus*, especially anteriorly. The principal anterior cusps are united together for most of their elevation, while the anterior inner is much smaller and lower, and is situated between the middle and inner side of the anterior cusp. The heel is rather wide, and has a raised border. The external part of it is angular, and is somewhat within the vertical line of the base of the crown. The fourth premolar differs from that of the type the genus, *T. quivirensis*, in having two acute longitudinal tubercles situated close together on the heel.

The anterior masseteric ridge is very prominent. The masseteric fossa is strongly concave, but shallows gradually inferiorly. Its inferior border presents a low thickened ridge, which is recurved in front. This may be an individual character only. The inferior outline of the ramus is generally convex, and does not rise much below the masseteric fossa.

Measurements.		M.
Length of last four inferior molars		.0315
" true molars		.0230
Diameters of M. i.	anteroposterior	.0085
	transverse	.0055
Length of P-m. iv. on base		.0090
Depth of ramus at M.i		.0200
Thickness " "		.0085

This *Triïsodon* is not only materially smaller than the *T. heilprinianus*, but differs in the characters of the heel of the inferior molars. In that species the internal border is tubercular; in this one it is entire. The *T. conidens* and *T. quivirensis* differ in the arrangement of the anterior cusps.

Dedicated to my friend, Henry Carvill Lewis, professor of mineralogy and geology in the Academy of Natural Sciences, Philadelphia.

MIOCLÆNUS FEROX, sp. nov.

This new species is represented by three specimens. One of these includes various separate teeth and a considerable portion of the skeleton; a second includes loose teeth and a smaller number of bones of the skeleton; and the third consists of a part of a mandibular ramus, which contains the three true molars. These indicate the largest species of the genus yet known, the first individual above mentioned being about the size of a wolf.

The bones of the *Mioclænus ferox* enable me to refer the genus approximately to its proper position in the system. Although we do not possess the corresponding parts of the *Mioclænus turgidus*, the type of the genus, it is probable, if not certain, that they agree in generic characters. The agreement in dentition extends to all the principal technical points, though the specific differences are marked.

The skeleton is that of a creodont. The unequal phlanges are compressed claws, and the metapodial bones have protuberant condyles. The astragalus has a simple head with convex surface, and the trochlea is a shallow open groove.

The tubercular dentition refers this genus to the *Arctocyonidæ*.* With this family it is accordingly placed provisionally. It differs from the known fossil genera in the single tubercle of the internal part of the crown of the superior molars.

The species *M. brachystomus* and *M. etsagicus* of the Wasatch epoch must now be removed from this genus. I have shown that the former is an Artiodactyle. Now in technical points, the dentition of those species is identical with that of *Pantolestes* Cope, as well as with *Mioclænus*. Although the skeleton of the type of *Pantolestes, P. longicaudus* of the Bridger Beds, is yet unknown, it is safe to suppose that it does not differ from that of the *M. brachystomus*. I therefore refer the two species first mentioned to *Pantolestes*, and place that genus in the Artiodactyle sub-order.

* For the dentition of this family see Lemoine, Annales, Sc. Nat., 1878, July.

Char. specif.—The canines are well developed, and have a robust root. The crown is rather slender and is very acute. It is rounded in front, but has an acute angle posteriorly. It is not grooved, and the enamel is smooth. The single-rooted first superior premolar is situated close to the canine, and behind it is a short diastema. I have the probable first true molar or fourth premolar. The external cusps are rather small, and are well separated from each other. The inner outline of the crown is rather broadly rounded. The internal tubercle is connected on wearing, with an anterior transverse crest which terminates near the inner base of the anterior external cusp in an intermediate tubercle. There is a posterior intermediate tubercle. There is a cingulum all round the crown excepting at the posterior intermediate tubercle. The second (? first) true molar is like the one just described, but has relatively greater antero-posterior width. In this tooth the cingulum extends all the way round the crown.

There are but two inferior molars of this individual preserved, the second and third true. The former of these has a parallelogrammic outline with rounded angles. There are two posterior and two anterior rather large tubercles ; an anterior transverse ledge ; and a narrow external and posterior cingulum, the latter running into the internal posterior tubercle. The latter has a circular section, and is much smaller than the external posterior, which has a wide crescentic section. Of the anterior tubercles the anterior is much the larger, judging from its worn base. The third true molar is triangular in outline. Its crown includes two anterior and an external median tubercle. The inner and posterior parts of the crown form a wide shelf, with the internal edge denticulate. A weak external cingulum.

Measurements of Teeth.

		M.
Diameters base of crown of incisor	anteroposterior	.0045
	transverse	.004
Diameters base crown of canine	anteroposterior	.0130
	transverse	.0095
Diameters crown, superior M. i.	anteroposterior	.0095
	transverse	.0120
Diameters, M.? ii.	anteroposterior	.0110
	transverse	.0110
Diameters of inferior M. ii	anteroposterior	.0120
	transverse	.0105
Diameters of inferior M. iii.	anteroposterior	.0125
	transverse	.0090

The second individual includes part of the superior walls of the skull. The fragment displays a high sagittal crest, which is fissured in front so as to keep the temporal ridges apart to near its anterior apex. The brain surfaces show small, smooth, flat hemispheres, separated by a constriction from the wide and large olfactory lobes. The navicular bone shows three well defined distal facets, indicating probably five digits in the pes. The teeth of this specimen include a posterior superior molar, and an inferior

third or fourth premolar, with other teeth. The premolar is like that of a creodont. Its principal cusp is a simple cone. To this is added a short wide heel, whose superior surface is in two parts, a higher and a lower, divided by a median ridge. A low anterior basal lobe, and a weak external cingulum.

The third specimen belonged to an individual a little smaller than the other two. It includes the first inferior true molar, a tooth lost from the others. Its form is somewhat narrowed anteriorly, where it has two low, but well separated anterior inner tubercles, which form a V with the external anterior.

Specimen No. 1 is accompanied by fragments of vertebræ and limbs. The former are principally from the lumbar region, but fragments of the atlas remain. This vertebra is of moderate length, and the cotylus is somewhat oblique. The vertebrarterial canal is rather elongate, and its anterior groove-like continuation in front of the diapophysis is not deeply excavated. The lumbar vertebræ are remarkable in the characters of their zygapophyses. These display subcylindric surfaces of the posterior pair, which indicates that the anterior ones are involuted, as in the specialized Artiodactyles and Perissodactyles of the later geological ages. Such a structure does not exist among carnivora, nor to my knowledge among creodonta, nor in any mammals of the Lower Eocene. I do not find it in *Didelphys* nor *Phascolarctos*, but it exists in a moderately developed degree in *Sarcophilus*. The articular surface forms more than half of a cylinder, and its superior portion is bounded within by an anteroposterior open groove. The surface within this is not revolute, as in *Bos* and *Sus*, but the articular surface disappears, as in *Cervus*. Eight such postzygapophyses are preserved, all disconnected from their centra. Two of them are united together. There are two other separated zygapophyses of smaller size, which have but slightly convex surfaces. One is probably a prezygapophysis of a dorsal vertebra. No centrum is preserved.

Of the anterior limb there is a probable distal half of a radius. It is of peculiar form, and resembles that of *Sarcophilus ursinus* more than any other species accessible to me. One peculiarity consists in the outward look of its carpal surface, which makes an angle of about 45° with the long axis of the shaft. The obliquity in *S. ursinus* is less. The external border of the shaft in *M. ferox* is, however, straight, and terminates in a depressed tuberosity. Beyond this, the border extends obliquely outward to the carpal face, which it reaches at a right angle. The internal border of the shaft is gradually curved outwards to the external border of the carpal face. Its edge is obtuse, while the external one is more acute for a short distance, and rises to the anterior (superior) plane of the shaft. The carpal face is a spherically subtriangular with rounded angles. It displays two slightly distinguished facets, one of which is superior, and the other is larger and surrounds it, except on the superior side. The internal marginal projection, or "styloid process," is not so prominent as in *S. ursinus*, and is a roughened raised margin. Joining it on the inferior edge of

the carpal face is another rough projection of the margin. Immediately opposite this, on the superior edge of the carpal face, is a rough tuberosity, which encloses a small rough fossa, between itself and the styloid process. Internal to it is a shallow groove for an extensor tendon of the manus; then a low short ridge, and internal to that a wide shallow depression for other extensors. The carpal face differs greatly from those of *Sarcophilus* and *Didelphys* in having the inner portion wider than the outer, instead of the reverse, and in having no distinct styloid process. It indicates that the manus was turned outwards much more decidedly than in those genera.

Of carpal bones the only recognizable one is the unciform. Its proximal articular surface rises with a strong convexity entad, and descends to an edge ectad. The metacarpal surface is concave in anteroposterior section, forming a wide shallow groove, extending in the direction of the width of the foot. Its two metacarpal areas are not distinguished. The entire first and second metacarpals, with the heads of the third and fourth are preserved. They considerably resemble those of *Sarcophilus ursinus*. The distal articulations are injured in both, but both display a sharp trochlear keel posteriorly, which on the second extends nearly to the superior face of the articulation. The condyle is subround, and is constricted laterally, and at the base above. The second metacarpal is short and robust, shorter than in *Sarcophilus ursinus*. The first is also robust, but is relatively longer, as it is three-quarters the length of the second. Its head is expanded, especially posteriorly, and the large trapezial face is subtriangular, with round apex directed inwards as well as forward. The posterior face of the head is notched ectad to the middle. On the external side of the head there is a vertical facet with convex distal outline, for contact with the second metacarpal. The head of the latter is narrow, and is concave between the sides. The concavity is bounded posteriorly by a raised edge. The anterior part of the proximal facet is decurved. The shaft is deep proximally, but on the distal half is wider than deep. The lateral distal fossæ are remarkably deep and narrow, the condyle very much contracted. The head of the supposed third metacarpal is as wide as the second anteriorly, but narrows to the posterior third, and then contracts abruptly to a narrow apex. The supposed external side of the head is perfectly straight, and is continuous with the side of the shaft without interruption. The entad side displays no facet, but has a depression below the head which adapts itself very well to the head of the first metacarpal. In fact, if the metacarpals just named second and third, exchange places, so that second is placed third and third second, the metacarpal series fits far better. The fourth fits the so-called second much better than the so-called third. This may therefore be the true order, although that first used agrees better with the carpus of *Sarcophilus*. The head of the so-called third is slightly convex anteroposteriorly, and is oblique laterally, descending a little to the inner side. The fourth metacarpal is wider anteriorly than either the second or third. The inner edge is straight, while

the outer is concave, the head being narrower before than behind. It has a lateral facet on each side ; the inner plane, the external concave in the vertical as well as in the anteroposterior direction. It thus approaches the form of a metatarsal, but is not so strongly excavated, nor is the head notched on either side. The unciform face is convex anteroposteriorly and plane transversely.

The *femur* is broken up so that I cannot restore it. The head of the *tibia* is gone, but a considerable part of the astragalar face is preserved. This is transverse to the long axis of the tibia. It is narrowed anteroposteriorly next the fibular facet. Malleolus lost. The shaft is robust, and does not expand distally for articulation with the astragalus. Three centimeters proximal to the distal end, the external side throws out a low, rough, ridge-like tuberosity. Above the middle the crest turns outwards, leaving the internal face convex. There is a broken patella, which has one facet much wider than the other.

The *astragalus* has the trochlear portion a little oblique. That is, the internal crest is a little lower than the external, and the inner face is a little sloping. The latter is impressed by a fossa above the posterior part of the sustentacular facet, which runs out on the neck. The trochlea has a shallow groove which is nearer the external than the internal crest, and which passes entirely round the posterior aspect to the plane of the inferior face of the astragalus. The groove for the flexor tendon is thus entirely enclosed, and issues on the inferior face at the posterior extremity of the groove which separates the sustentacular from the condylar facets. The external crest of the trochlea is less prominent posteriorly than the internal, thus reversing the relations of the superior part. The internal ridge becomes quite robust, but does not flatten out and project sub-horizontally as in *Oxyæna forcipata*. The fibular face is vertical ; neither its anterior nor posterior angles are produced. The neck is somewhat contracted (the internal side is injured). The head is a transverse oval, strongly convex vertically, moderately so horizontally, and without flattening. A *mesocuneïform* (or possibly *ectocuneïform*) bone is wedge-shaped in horizontal section, without posterior tuberosity, and its anterior face is a slightly oblique square. The narrower facet is oblique in the transverse sense.

The *metatarsals* are represented, excepting the first and second. The only complete one is the fifth. The heads of the third and fourth are much like those of *Oxyæna forcipata*, and of about the same size. Their anterior width is equal, and in both the external side is more oblique than the internal. Both have a notch at the middle of the internal side, but they differ in that the third has an open notch on the external side which is wanting to the fourth. The lateral excavations of the external sides are deep and rather large, and thin out the anterior external edge. The lateral facets are correspondingly large on the fourth and fifth ; on the third metatarsal it is small, and a mere decurvature of the proximal surface. That of the fourth is longer proximo-distally than transversely. That of the fifth is about as long as wide, and presents more anteriorly ; or, to express it

more accurately, the shaft and head present more outwardly than those of the fourth. The proximal, or cuboid facet is narrow anteroposteriorly, and is curved, the external side being concave. On the external side just distal to this facet, the head of the bone expands into a large outward-looking tuberosity, which is separated from the posterior tuberosity by a strong notch. Between it and the head proper, on the anterior face, is a large fossa. The entire form is something like that of the proximal extremity of a femur with head, neck, great trochanter and trochanteric fossa. A somewhat similar form is seen in the corresponding bone of *Oxyæna forcipata.* The shaft of the fifth metatarsal, is one-fifth longer than that of the second metacarpal (? 3d) above described. Its direction is straight, but it is somewhat curved anteroposteriorly. Its section is subtriangular, the apex external. The condyle is narrowed and sub-globular above, and spreads laterally behind, the external expansion being wide and more oblique. The keel is prominent, and is only visible from above (in front) as an angle. The distal extremities of some other metatarsals differ in being flatter at the epicondyles, and concave between them on the posterior face. The condyles are more symmetrical, and are bounded above on the anterior face by a profound transverse groove. Several *phalanges* are preserved, including part of an unguis. They are all depressed, and with well marked articular surfaces, of which the distal are well grooved, and the proximal notched below. The lateral areas of insertion of the tendons of the flexors are well marked on the edges of the posterior faces. An ungual phalange is much compressed at the base. The basal table is well marked, and has a free lateral edge. The nutritive foramen enters above the posterior extremity of this edge. No trace of basal sheath.

Measurements of No. 1.

		M.
Length of atlas at anterior vertebrarterial foramen		.0165
Expanse of postzygapophyses of a lumbar vertebra		.0230
Diameter radius at middle of shaft		.0100
Greatest distal width of radius		.0220
Diameters carpal surface	vertical	.0140
	transverse	.0185
Diameters of unciform	vertical (interiorly)	.0130
	anteroposterior (greatest)	.0140
	transverse (in front)	.0150
Diameters head metacarpal I	anteroposterior	.0130
	transverse	.0120
Length of metacarpal I		.0310
Width metacarpal I at epicondyles		.0110
Diameters head metacarpal II	anteroposterior	.0110
	transverse	.0070
Length of metacarpal II (or III)		.0400
Width do. at epicondyles		.0120
Diameter head of M. III (or II)	anteroposterior	.0125
	transverse	.0075

Measurements of No. 1.			M.
Diameters head of M. IV	anteroposterior		.0120
	transverse (at middle)		.0070
Width of patella near middle			.0190
Diameters of tibia .07 M. from astragalus	anteroposterior		.0185
	transverse		.0130
Anteroposterior width of astragalar face			.0200
Total length of astragalus			.0310
Diameters of the trochlea	length on groove		.0210
	width above		.0160
	elevation externally		.0130
Greatest width of astragalus below			.0225
Length anterior to internal crest of trochlea			.0100
Diameters head of metatarsal III	anteroposterior		.0130
	transverse (in front)		.0110
Diameters head of metatarsal IV	anteroposterior		.0140
	transverse		.0105
Diameters head M. V	without tuberosity	anteroposterior	.0120
		transverse, with lateral facet	.0080
		transverse, without do.	.0040
	transverse over all		.0170
Length Mt. V			.0460
Width do. at epicondyles			.0120
Width do. at condyle above			.0065
Width of M. III or IV at epicondyles			.0120
Width of proximal end of phalange			.012
Length of smaller phalange (1st series)			.0230
Proximal diameter do.	vertical		.0070
	transverse		.0110
Ungual phalange, vertical diameter of cotylus			.0090

The specimen which has been partially described in the preceding pages as No. 2, has many pieces which are identical with those preserved in specimen No. 1. Among these may be mentioned the glenoid cavities of the squamosal bone. These display, besides the large postglenoid process, a well developed preglenoid ridge, as in *Arctocyonidæ*, *Oxyænidæ* and *Mesonychidæ*. A large distal caudal vertebra of elongate form, indicates a long tail. An articular extremity of a flat bone is intermediate in form between the proximal end of the marsupial bone of *Didelphys* and that of *Sarcophilus*. Its principal and transverse articular surface is transversely convex, as in the latter (*S. ursinus*), but the lesser articular face is separated from it by an even shorter concave interspace than in the opossum. It has almost exactly the form of that of the latter animal. It is a short, flat cone, with two faces presenting on the same side, the one part of the concavity mentioned, the other flat and presenting away from it. This

piece has a slight resemblance to the very peculiar head of the fibula in the oppossum, but is not like that of *Sarcophilus ursinus.* I, however, think it much more probably the proximal extremity of a marsupial bone.

A supposed *cuneïform* is subtransverse in position, and resembles in general those of *Oxyæna* and *Esthonyx.* It has the two large transverse proximal facets, the anterior one-quarter wider than the posterior. The distal facet (trapeziotrapezoidal) is simple. The *navicular* is much like that of *Oxyæna forcipata,* but is more robust. Its external tuberosity is flattened anteroposteriorly, and is produced proximally. The three distal facets are well marked; the median a little wider than the external, while the internal is subround, convex, and sublateral in position. The *entocuneïform* is a flat bone, with cup-shaped facet for the navicular, and narrow facet for the first metatarsus. This facet is transverse transversely, and concave anteroposteriorly. It shows (1), that there is a pollex; (2), that it is probably small; and (3), that it was not opposable to the other digits, as is the case in the opossum. (4). It does not show whether the pollex has an unguis or not.

Measurements No. 2.		M.
Transverse width condyle of mandible		.0230
Anteroposterior width condyle of mandible (at middle)		.0103
Diameters head of *os marsupii*	transverse	.0220
	anteroposterior	.0068
Diameters cuneïform	vertical	.0075
	anteroposterior	.0115
Diameters navicular	vertical in front	.0085
	transverse	.0180
	anteroposterior (middle)	.0110
Diameters ectocuneïform	vertical at middle	.0100
	anteroposterior (middle)	.0140
	transverse distally	.0060

Two other bones of specimen No. 2 I cannot positively determine. The first resembles somewhat the trapezium of *Sarcophilus ursinus,* and still more that of *Didelphys.* I will figure it, as a description without identification will be incomprehensible. The next bone is of very anomalous form. It may be the magnum, which is the only unrecognized bone of importance remaining, or it may be a large intermedium. It has no resemblance to the magnum of any mammal known to me. It was evidently wedged between several bones, as it has eight articular facets. Two are on one side; the largest (convex and oval) is on one edge; three are on one end, and two, the least marked, are on the other flat side, opposite to the first.

Restoration. We can now read the nature of the primitive mammal *Mioclænus ferox,* in so far as the materials above discussed permit. It was a powerful flesh-eater, and probably an eater of other things than flesh. It had a long tail and well-developed limbs. It had five toes all around, and the great or first toe was not opposable to the others, and may have been

rudimental. The feet were plantigrade and the claws prehensile. The fore feet were well turned outwards. There were in all probability marsupial bones, but whether there was a pouch or not cannot be determined. These points, in connection with the absence of inflection of the angle of the lower jaw, render it probable that the nearest living ally of the *Mioclænus ferox* is the *Thylacynus cynocephalus* of Tasmania. The presence of a patella distinguishes it from Marsupials in general. Its dentition, glenoid cavity of the skull and other characters, place it near the *Arctocyonidæ.* Should the forms included in that family be found to possess marsupial bones, they must probably be removed from the *Creodonta* and placed in the *Marsupialia.*

This species is about the size of a sheep. The bones are stated by Mr. Baldwin, who discovered it, to be derived from the red beds in the upper part of the Puerco series.

MIOCLÆNUS BUCCULENTUS, sp. nov.

A part of the right maxillary bone which supports three molars indicates this species. The molars are P-m IV, M. i and M. ii, This series is characterized by the remarkably small size of the fourth premolar, and large size of the second true molar. The first true molar is intermediate.

The fourth premolar consists of an external cone and a much smaller internal one. There is a weak posterior basal cingulum. The reduced size of the internal cone suggests the probability that the third premolar has no internal cusp, and that there may be but three premolars. In either case the species must be distinguished from *Mioclænus.*

The first and second true molars have conic well separated external cusps, and a single pyramidal internal cusp. The intermediate tubercles are distinct. There is a posterior cingulum which terminates interiorly in a flat prominence. There is an anterior cingulum and a strong external one, which form a prominence at the anterior external angle of the crown. Enamel wrinkled.

Measurements of Superior Molars.		M.
Length of bases of P-m. iv M. i and ii		.0180
Diameters P-m. iv	anteroposterior	.0040
	transverse	.0046
Diameters of M. i	anteroposterior	.0060
	transverse	.0065
Diameter of M. ii	anteroposterior	.0070
	transverse	.0085

MIOCLÆNUS SUBTRIGONUS Cope.

This species has been known hitherto* from a palate with three molars. I am now able to give the characters of the inferior molar series, which have been found, by Mr. Baldwin, associated with the true superior molars. Of the latter it may be remarked that the second true molar is not so much

*American Naturalist, 1881, 490–1.

longer than the first as in *M. bucculentus,* although the difference in size is very evident. The third is smaller than the first, and ovoid in outline, while the first and second are subquadrate. The external cusps are conic and widely separated and the intermediate areas are distinct. There is a cingulum all round the crown of the last two, and round that of the first except at the inner side, and at the anteroëxternal angle.

The last three inferior premolars are higher than long at the base, and are compressed and the apex acute. The posterior edge of the third and fourth is truncate, and simple. Each has a posterior cingulum which forms a narrow heel on the fourth. No other cingula. Of the true molars only the second is wanting. The form of these is like those of the *M. ferox,* with the cusps more prominent. The first only has trace of the anterior V; in the others, the two anterior tubercles are opposite and connected by a short anterior ledge. The heel of the first consists of a basin bounded by these tubercles, of which the external is pyramidal and largest. The median posterior is small. The heel of the third is narrow and prominent, and the internal lateral tubercle is represented by a short raised edge. The enamel of all the molars is wrinkled, and the inner side of the premolars is grooved with the height of the crown. A weak external cingulum on M. iii.

Measurements.		M.
Length of last three superior molars		.0265
Diameters of M. i	anteroposterior	.0060
	transverse	.0060
Diameters of M. ii	anteroposterior	.0062
	transverse	.0072
Diameters of M. iii	anteroposterior	.0047
	transverse	.0060
Length of last inferior molars		.0340
Length of last three premolars		.0140
Length of P-m. iv		.0050
Elevation of P-m. iv		.0050
Diameters of M. i	anteroposterior	.0057
	transverse	.0042
Diameters of M. iii	anteroposterior	.0070
	transverse	.0035

Rather larger than the pine weasel, *Mustela americana.*

MIOCLÆNUS CORRUGATUS, sp. nov.

This species is known from a right maxillary bone which contains the last four molar teeth, with parts of pelvis and other bones of one individual.

This species is intermediate in size between the *M. protogonioides* and *M. ferox,* as the following measurements of the second superior true molar show:

	M. protogonioides.	*M. corrugatus.*	*M. ferox.*
Diameter, transverse	.011	.0118	.015
" anteroposterior	.008	.010	.013

The superior molars are more nearly quadrate than in the other species of the genus, owing to the better development of the posterior internal tubercle, which is, however, as in the others, a mere thickening of the posterior cingulum. It is wanting from the last superior molar. The cusps on the true molars are as in the *M. ferox*, small, and not large and closely placed as in *M. protogonioides.* The intermediate ones are nearly obsolete. The crowns are all entirely surrounded by a cingulum. The entire enamel surfaces wrinkled so as to be rugose, although the teeth are those of an adult and well used. The second superior molar is larger than the first, exceeding it in the transverse rather than the fore-and-aft diameter. The third is the smallest, and is of oval form with obliquely truncate external face. It is less reduced than in the *M. turgidus.*

The fourth premolar consists of a strong compressed-conic cusp with three basal cusps of small size, viz., an anterior, a posterior, and an internal. The last is the larger, though small, is formed like a heel, and is connected with the others by a cingulum. No external cingulum.

Measurements.		M.
Length of last four molars		.036
Diameters P-m. iv	anteroposterior	.010
	transverse	.008
" M. i	anteroposterior	.010
	transverse	.010
" M. iii	anteroposterior	.008
	transverse	.011

From the Upper Puerco beds.

PANTOLAMBDA BATHMODON Cope, American Naturalist, 1882, p. 418.

In describing this genus and species, I remarked, loc. cit., that they were "founded on a mandibular ramus, which supports the first true molar, and the last two premolars. The characters of these teeth remarkably resemble those of *Coryphodon.* * * * It will be for additional material to demonstrate whether this genus belongs to the *Amblypoda* or *Perissodactyla.*"

A considerable part of the skeleton of this species having been recently sent me by Mr. D. Baldwin, I am able to throw much light on the affinities of this curious genus.

In the first place, the phalanges (not ungual), show that the genus is ungulate. Secondly, the astragalus has a large distal facet for the cuboid bone. This proves that the genus cannot be referred to the Taxeopod order. The question as to whether it belongs to the *Amblypoda* or the *Diplarthra* would be decided by the carpus, but that part is unfortunately not preserved, and I have to rely on empirical indications for a provisional determination. Apart from the astragalus, the characters are those of the *Condylarthra* rather than of the *Perissodactyla*, and it is therefore to be supposed that the carpus has also the characters of that order. This would

place the genus in the *Pantodonta*, which has the carpus nearly that of the *Taxeopoda*, and the tarsus of the *Diplarthra*. The points of resemblance to the *Condylarthra* are the following: The ilium is narrow. The humerus has an epitrochlear canal. The superior molar teeth have but one internal lobe. The resemblances to the *Pantodonta* are these: The cervical vertebræ are plane and short. The femur has a third trochanter. The premaxillary bone in dentigerous. The astragalar trochlea is as in the *Periptychidæ*, and the *Proboscidia;* that is without groove, and slightly convex anteroposteriorly, thus differing from that of the *Pantodonta*. The dentition is especially like that of the *Amblypoda* in general, and that of the superior series is unlike anything known in the *Diplarthra*.

I propose to place this genus in the *Amblypoda* for the present, next to the *Pantodonta*, but it cannot enter that sub-order on account of the form of its astragalus. The sub-orders of *Amblypoda* will be defined as follows:

Astragalus with a head distinct from trochlea, with distal articular facets...*Taligrada*.
Astragalus without head; distal facets subinferior...........*Pantodonta*.

In the sub-order *Taligrada*, the single family *Pantolambdidæ* presents the following characters:

Superior and inferior molars with the cusps developed into Vs. Postglenoid process present; postympanic and paroccipital not distinct. All the vertebræ with plain articulations. Humeral condyles without intertrochlear ridge. Femur with third trochanter. Digits of posterior foot probably five. Metapodial keels small and posterior.

Of this family *Pantolambda* is as yet the only known genus. Its leading characters are as follows:

Canine teeth distinct; dental series continuous. Superior molars all triangular, that is with a single internal cusp. External cusps of premolars unknown; of molars two. Internal cusp V-shaped, sending its horns externally as cingula to the anterior and posterior bases of the external side of the crown, without intermediate tubercles. Inferior true molars with a crown of two Vs, the anterior the more elevated. Premolars consisting of one open V, with a short crest on a short heel, as in *Coryphodon*. Dental formula I? $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{?4}{?4}$; M. $\frac{3}{3}$; the last inferior with a heel. A strong sagittal crest. Auricular meatus widely open below. Large postparietal, postsquamosal and mastoid foramina.

Cervical vertebræ rather short; other vertebræ moderate, the lumbars not elongate. A large tail. Humerus with large internal epicondyle. Femur with all the trochanters large. Ilium with the anterior inferior spine well developed. Metacarpals short, plantigrade. Phalanges of second series flat, and of subquadrate outline. The astragalus has a wide head, but no neck, as it is not separated from the tochlear portion by a constriction. It is as wide as the trochlear portion, but about one-third of its length extends within the line of the malleolar face of the trochlear portion. The

navicular face is flat, that of the cuboid bone is convex vertically, and one-half as long horizontally as the navicular, and only half as deep. These two facets are continuous with the sustentacular below. Interior to all of these, on the internal tuberosity of the head is a sub-round facet looking inwards, like that characteristic of the genus *Bathmodon*, but relatively larger. A continuous facet is seen on the adjacent edge of the navicular. The use of these facets is unknown.

The brain case indicates small and nearly smooth hemispheres, extending with little contraction into a rather large cerebellum. The olfactory lobes are produced anteriorly at the extremity of a rather long isthmus.

If we consider the dentition alone, *Pantolambda* is the ancestor of the *Coryphodontidæ*. The history of the feet requires further elucidation.

The *Pantolambda bathmodon* is about as large as a sheep.

From the upper beds of the Puerco.

MIXODECTES PUNGENS, gen. et sp. nov.

Char. Gen.—The position of this genus is uncertain, but may be near to *Cynodontomys* Cope, which I have provisionally placed among the Prosimiæ*. It is only known from mandibles, which have presumably the following dental formula. I. 0; C. 1; P-m. 4; M. 3. An uncertainty exists as to the proper names of the anterior teeth, which cannot be decided until the discovery of the superior series. For instance the formula may be; I. 1; C. 1; P-m. 3.

The supposed canine is a large tooth, issuing from the ramus at the symphysis like a rodent incisor, and has an oval section, with long diameter parallel to the symphysis. The crown is lost from all the specimens. The second tooth is similar in form to the first, but is much smaller. It is situated posterior and external to the first. The next tooth is still smaller and is one-rooted. The third and fourth premolars have simple conic crowns, and more or less developed heels without cusps. The true molars are in general like those of *Pelycodus; i. e.*, with an anterior smaller, and a posterior triangle or V. The supplementary anterior inner cusp is quite small, while the principal anterior inner is elevated. The posterior inner is much more elevated than in the species of *Pelycodus*. Last inferior molar with a fifth lobe.

This genus cannot be referred to its place without additional material, but the parts discovered indicate it to be between *Pelycodus* and *Cynodontomys;* either in the *Mesodonta* or the *Prosimiæ*. I may here remark that in defining the latter genus I was in doubt as to the number of the inferior premolars. The discovery of the present genus renders it probable that it has three such teeth, and that the anterior two are each one-rooted.

Char. Specif. The mandible of the *Mixodectes pungens* is about the size of that of the mink. Its inferior outline is straight to below the second premolar, whence it rises upwards and forwards like that of a rodent. The anterior masseteric ridge is very prominent, but terminates below the

* Paleontological Bulletin No. 34, p. 151.

middle of the ramus. Inferior masseteric ridge much less pronounced. The inferior part of the ramus is robust below the base of the coronoid process, but there is no indication of recurvature of the edge. Mental foramina two ; one below the front of the first true molar, and one below the second premolar.

The oval base of the canine is not flattened on either side; that of the second tooth is flattened on the inner side. There is a great difference between the sizes of the last three premolars. The fourth is twice as large as the third, and the second, judging from the space and the size of its alveolus, was much smaller than the third, and the crown was probably a simple acute cone. The crown of the third is of that form, with the addition of a short heel. The long axis of the base of the crown is diagonal to that of the jaw. The fourth premolar has a relatively larger heel than the third, but it is shorter than the diameter of the base of the cusp. Its posterior edge is elevated. The cusps ot the anterior pair of the true molars are elevated, but the interior is the most so. The supplementary one is not exactly in the line of the interior border of the crown. Each of the inner cusps are connected with the base of the external by a ridge, which together form a V. The posterior base is nearly surrounded by a raised edge, which rises into cusps at the posterior lateral angles. Of these the internal is the more prominent. The edge connecting these cusps is slightly convex backwards, and evidently bears a part in mastication. The lateral borders of the last molar are somewhat expanded, and the fifth lobe is very short. No cingula on any of the teeth.

Measurements.		M.
Length of dental series from "canine" exclusive		.0265
" true molar series		.0140
Diameters "canine"	longtitudinal	.0040
	transverse	.0030
Long diameter of base of "P-m. i"		.0028
" " " P. m-ii		.0017
Diameters P-m. iv	vertical	.0055
	anteroposterior	.0050
Diameters M. ii	transverse	.0038
	anteroposterior	.0050
Length of crown of M. iii		.0060
Depth of ramus at P-m. iii		.0090
" " M. iii		.0100

MIXODECTES CRASSIUSCULUS, sp. nov.

This mammal is represented by fragments of two mandibles from different individuals ; one less and the other more worn by mastication. The species differs from the last in its greater size, and in the relatively greater length of the last inferior molar. The length of the posterior four molars of the *M. pungens* equals that of the three true molars of the *M. crassius-*

culus; and the last true molar of the latter is half as long again as the penultimate, while in *M. pungens* it exceeds it but little.

The best preserved true molar is the second. Its most elevated cusps are the anterior and posterior inner, of which the anterior is subconic and more elevated. The anterior external cusp is crescentic in section, and sends crests to the supplementary, anterior, inner and the posterior anterior inner, both of which descend inwards. The posterior crest reaches the posterior base of the anterior inner cusp.

The posterior external cusp is an elevated angle, sending crests forward and backwards. The former reaches the base of the anterior external cusp (not reaching the inner), while the latter passes round the posterior edge of the crown. As in *M. pungens*, it is convex posteriorly, and rises to the posterior internal cusp. In both species its appearance indicates that it performs an important masticatory function in connection with the superior molar. No cingula.

Measurements.

		M.
Length of bases of M. ii and iii; (No. 2)		.0125
" base of M. iii; (No. 2)		.0070
Diameters crown M. ii; (No. 1)	anteroposterior	.0056
	transverse	.0050
Depth of ramus at M. ii; (No. 1)		.0100

Periptychus carinidens Cope.

Additional specimens of this species demonstrate that the last inferior molar has a different form from that of the *P. rhabdodon*. While of the same length, it is narrower throughout, conformably with the smaller size of all the other molar teeth.

Phenacodus calceolatus, sp. nov.

This species is founded on fragments of the skull and limbs, with teeth, of a single individual. The teeth consist of two superior and four inferior molars of one side, and a smaller number of those of the opposite side.

The teeth are of the size of those of the *Phenacodus puercensis*, and like that species, there is no median external cingular cusp of the superior molars. In these teeth the external basal cingulum is weak, but there is a strong anterior cingulum, distinct from any of the cusps. No internal cingulum. External cusps conical, well separated; intermediate cusps rather large; internal cusps rather large, close together, but deeply separated. The last superior molar is reduced in size. It has well developed anterior and posterior cingula, a weak external, and no internal cingula. The intermediate tubercles are rather large, and there is one large internal tubercle.

The heel of the last inferior molar is short, wide and rounded. The posterior tubercle is but little behind, opposite the posterior internal tubercle. The latter is separated from the anterior inner by a deep fissure, while the opposite side of the crown is occupied by a large median exter-

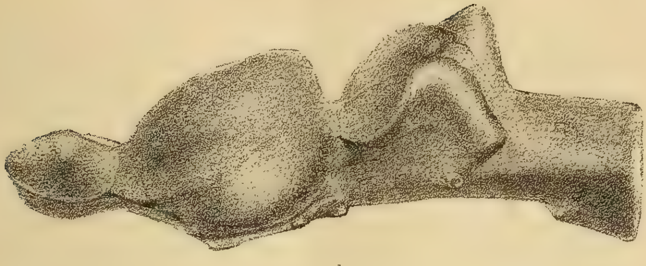
nal cusp, which has a semicircular section. The large anterior cusps are confluent on wearing. No anterior cingulum in the worn crown. The crowns of the first and second true molars of the specimen are rather worn. They show that the posterior median tubercle is very indistinct and probably absent. The bases of the smaller inner cusps are round, and on wearing unite with the larger external cusps. Of the latter the posterior is the larger. Anterior cingulum rudimental or wanting. No lateral or posterior cingula. The principal peculiarity of the lower dentition of this species and the one from which it is named, is the form of the third or fourth (probably third) premolars, both of which are preserved. They have a compressed apex, which descends steeply to the anterior base, without basal or lateral tubercle. The base of the crown spreads out laterally behind, and is broadly rounded at the posterior margin, so as to resemble the toe of a wide and moccasined foot. It is depressed, the surface rising to the apex from a flat base.

Measurements.		M.
Diameters of second superior molar	anteroposterior	.0080
	transverse	.0100
Diameters of last superior molar	anteroposterior	.0067
	transverse	.0085
Length of inferior true molars		.0258
Diameters of M. ii	anteroposterior	.009
	transverse	.008
Diameters of M. iii	anteroposterior	.0085
	transverse	.0068
Diameters of the P-m. iii	anteroposterior	.008
	transverse	.005

About the size of the *P. puercensis.*

Note on the Mammalia of the Puerco and the Origin of the quadrituberculate Superior Molar.—It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular; that is, with two external, and one internal tubercles. Thus of forty-one species of Mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of these thirty-eight triangular ones we may except those of three species of *Periptychus*, which have a small supplementary lobe on each side of the median principal inner tubercle.

This fact is important as indicating the mode of development of the various types of superior molar teeth, on which we have not heretofore had clear light. In the first place, this type of molar exists to-day only in the insectivorous and carnivorous Marsupialia; in the Insectivora, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades). In the Ungulates the only traces of it are to be found in the molars of the *Coryphodontidæ* of the Wasatch, and *Dinocerata* of the



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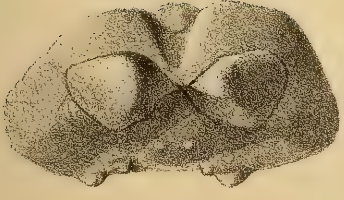

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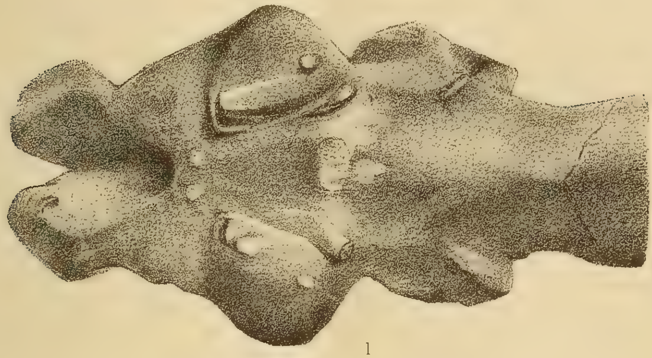
4

T. Sinclair & Son, Lith. Phila.

PHENACODUS PRIMAEVUS ½



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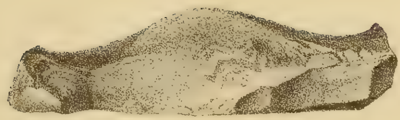

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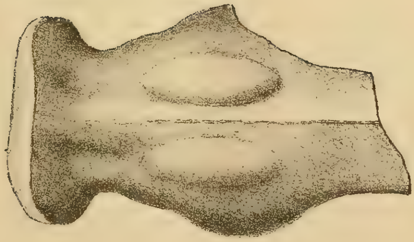

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T. Sinclair & Son, Lith. Phila.

1. PHENACODUS PRIMAEVUS ½. 2-3. PERIPTYCHUS RHABDODON ⅓.

Bridger Eocenes. In later epochs it is chiefly seen only in the last superior molar.

It is also evident that the quadritubercular molar is derived from the tritubercular by the addition of a lobe of the inner part of a cingulum of the posterior base of the crown. Transitional states are seen in some of the *Periptychidæ* (*Anisonchus*) and in the sectorials of the *Procyonidæ.*

On the Brains of the Eocene Mammalia Phenacodus and Periptychus. By E. D. Cope.

(*Read before the American Philosophical Society, December 15, 1882.*)

PHENACODUS PRIMÆVUS Cope.

A cast of the cranial cavity gives the following as the general characters of the brain. The cerebal hemispheres are remarkably small, each one being less by one-quarter than the cerebellum. They are separated from the latter and from the large olfactory lobes by strong constrictions. The posterior one is occupied by a thick tentorium. In like manner a wide groove for a robust falx separates the hemispheres above, a notch represents the sylvian fissure, and the lobus hippocampi is quite large. The vermis of the cerebellum is quite distinct, and the lateral lobes are large. They are impressed laterally by the petrous bones as in various ruminants. The anterior columns of the medulla are not visible. There are traces of the convolutions on their hemispheres.

The brain displays the following more special features. The olfactory lobes are as wide as long, and they diverge, having two external sides. In section they are triangular, presenting an angle downwards. The hemispheres are depressed, and wider posteriorly. They are well separated from each other and from the cerebellum; so much so that it is quite probable that the copora quadrigemina are exposed. Their outlines are however not distinguishable on the flat surface which connects the hemispheres posteriorly. No further indication of sylvian fissure can be seen in the cast beyond an entering angle defining the lobus hippocampi anteriorly. The latter is prominent externally, and less so downwards. There are distinct indications of convolutions. There are three on each side above the sylvian convolution, and a fourth extends from the sylvian upwards and posteriorly below the posterior part of the third or external convolution. The sulci separating the convolutions are very shallow. The internal and external convolutions unite anteriorly, passing round the extremity of the median convolution. The space between this gyrus and the base of the olfactory lobe is only three millimeters.

The cerebellum is larger than a single hemisphere. Its superior surface is somewhat flattened, and descends forwards; the lateral boundary of this face is a projecting edge which rises behind to an angle of the vermis. The posterior face is shorter than the superior, and is vertical. It is separated by a space from a very prominent lateral convolution, while the region of the flocculus is concave from the internal form of the ascending portion of the petrous bone. This concavity is open anteriorly. The base of the fifth pair of nerves is below its apex, and that of the sixth below the inferior extremity of the lateral convolution. The section of the medulla oblongata is a transverse oval; its inferior face and that of the pons varolii, smooth. A deep fossa just anterior to the bases of the optic nerves.

Measurements of brain.	M.
Length from vermis to olfactory lobes inclusive	.070
" of olfactory lobes from above	.015
" of hemispheres, from above	.030
" of cerebellum from above	.024
Depth of olfactory lobe	.010
" of hemisphere	.023
" of cerebellum and medulla	.026
" of medulla at vermis	.015
Width of olfactory lobes at middle	.030
" of hemispheres in front	.044
" " behind	.044
" of cerebellum	.036
" medulla at vermis	.020

PERIPTYCHUS RHABDODON Cope.

I have obtained a cast of the top and sides of the cerebral hemispheres, and the proximal portion of the olfactory lobes, from a skull of a *Periptychus* in which the teeth are preserved, and prove the species to be the *P. rhabdodon.* The olfactory lobes are enormous, and the hemispheres small and very flat. The *mesencephalon is entirely exposed.* The cerebral hemispheres are very flat, and are only differentiated from the olfactory lobes, by a moderate contraction and depression, which forms the peduncle of the latter. Only the proximal part of the olfactory lobes is preserved, but this expands so as to be only a little narrower than the hemispheres. The peduncle has a ridge on the median line, and a shallow fossa on each side of it. The lateral outlines of the hemispheres diverge, and the widest part is posterior. There is no indication of sylvian fissure. The transverse section of the hemispheres would be a flat arch, but for the presence of a longitudinal oval protuberance on each of them, which do not quite touch the median line, and which have definite boundaries. If their limits determine the size of the cerebral hemispheres, then the latter are wider,

than long, but they probably pass gradually into the mesencephalon behind them. These bodies remind one of the corpora olivæformia, and may represent the superior or median frontal convolutions. They are probably, however, not to be homologized with any convolutions, representing rather the cerebral vault of the lateral ventricle. Posterior to them the flat surface descends gently without indication of copora quadrigemina or other irregularity, and at a distance about equal to the length of the oval bodies, it begins to rise gently. The cranium is broken here, and no cast of the cerebellum was obtained.

I may remark that the cranium from which this cast is taken is not crushed, and that it consists of parts of the parietal and squamosal bones only. The latter remain as far as the incurvature to the pterygoid processes in front of the glenoid cavity.

Measurements of brain.	M.
Length from posterior rise to base of olfactory lobes....	.037
Length of oval bodies of hemispheres..................	.018
Width of proximal part of olfactory lobes..............	.027
Width of olfactory peduncles..........................	.021
Length from olfactory lobes to oval bodies of hemispheres....................................	.005
Diameter of hemispheres at posterior part of oval bodies.	.038
Depth from sagittal crest to olfactory lobes.............	.024

EXPLANATION OF PLATES.

Plate I.

Casts of the brain case of *Phenacodus primævus* Cope, natural size.

Fig. 1. Lateral view.
Fig. 2. Superior view.
Fig. 3. Anterior view.
Fig. 4. Posterior view.

Plate II.

Fig. 1. Brain of *Phenacodus primævus,* inferior view.
Fig. 2. Cast of brain case of *Periptychus rhabdodon,* superior view.
Fig. 3. Cast of brain case of *Periptychus rhabdodon,* lateral view.

*Fourth Contribution to the History of the Permian Formation of Texas. By E. D. Cope.**

(Read before the American Philosophical Society, March 16, 1883.)

PISCES.

ECTOSTEORHACHIS CICERONIUS, sp. nov.

The genus *Ectosteorhachis* Cope, is known up to the present time from ichthyolites, which do not exhibit the interior details of the structure of the skull. Several portions of crania having recently come into my hands, I am able to add some important features, and a new species, which I name as above.

The base of the skull consists of ossified parachordals, which embrace the chorda dorsalis posteriorly and are continued for a short distance posteriorly as a tube. Anteriorly the chordal groove is open. Trabeculæ not ossified. The cranial structure is an excellent illustration of a permanent embryonic type. Above and in front of the opening for the chorda, the neural canal enters the groove. The parachordals are subtriangular, presenting one angle forwards, and having the internal side that bounds the groove straight and longitudinally grooved. The anteroexternal side is oblique and nearly straight, and is overhung by the osseous roof of the skull. These characters are identical in both species.

The *E. ciceronius* differs from the *E. nitidus* in having a narrower interorbital region, and in the possession of small tubercles of ganoïne on the posterior parts of the superior surface of the skull. These are seen on the sides of the surface, and are quite small, not numerous, and

*The third contribution can be found at page 447 Proceedings of the Society for 1882.

of various sizes and shapes. They resemble shining seeds. In *E. nitidus* these points are wanting, but there are rugosities on the postfrontal and pterotic regions of a radiating character, not found in *E. ciceronius*.

Measurements.	M.
No. 1.	
Length of skull to occiput above (muzzle worn)	.069
Interorbital width	.014
No. 2.	
Length of osseous base of cranium (parachordal)	.039
" open median groove	.022
Width of base at parachordals	.036
" groove at apices of parachordals	.011
" foramen notochordæ	.0095

Found by Mr. W. F. Cummins.

Gnathorhiza serrata, gen. et sp. nov.

This presumed fish is represented by some teeth which are processes of osseous bodies, which may be roots properly so called, or may be jaws. The osseous bases are shallow, and thickened on the free edge, which is directed obliquely away from the plane of the crown of the teeth. The teeth obtained are flat, and doubtless bilaterally symmetrical, though no complete pairs are preserved. The largest of these has a curved edge, and a branch extending posteriorly at right angles to it, joining it at a point at one side of its middle. The longer (and more curved) part of the convex edge, has two coarse angles; the shorter part is finely denticulated, as is the transverse lamina. The principal edge is worn posteriorly by use. The external convex face is marked by coarse and finer lines of growth, like those on corneous processes. A second form of tooth is not curved, but flat, so far as preserved. It has three coarse obtuse teeth. Two other toothed bodies resemble it. All the teeth are covered with brilliant ganoïne on both sides.

Measurements.	M.
Length of chord of larger tooth	.010
" cross lamina	.0055
Elevation of principal edge	.006
" with root	.008
Thickness of root at base	.002

The genus *Gnathorhiza* may belong to the Petalodont family, though I think it very doubtful. The characters of the roots of the teeth are more like those of sharks.

BATRACHIA.

Trimerorhachis bilobatus, sp. nov.

Among the many specimens of animals of this genus which have passed through my hands, I have not until now been able to select more than one

species, the *T. insignis*. Mr. Cummins, however, now sends me parts of skeletons of four individuals, which present distinctive characters. Two of these include vertebral elements, and all embrace jaws and bones of the limbs and arches.

The vertebræ present no important difference from those of *T. insignis*, but the surface of the intercentrum is not yet cleaned of a thin layer of matrix. The peculiar character of this species is most readily seen in the posterior portions of the mandibular ramus. The angle consists of two subequal tuberosities which are separated by a deep groove, instead of one prominent one. The external tuberosity is represented in the *T. insignis* by a small protuberance of the lateral enlargement of the external face of the ramus. The extremity of this tuberosity is in the *T. bilobatus* strongly honeycombed, and it is bounded below and externally by a groove which is faintly indicated in *T. insignis*. Above it, on the inner side, is another, shallow groove, from which it is separated by a sharp ridge. Both grooves are smooth. The superior one is wanting in *T. insignis*. The quadrate cotylus is more depressed externally than in *T. insignis*, thus making it more oblique. The internal fossa of the cotylus is not divided by a longitudinal groove, as it is in *T. insignis* The dental foramen is large, and is located as in the *T. insignis*. There is also an inferior longitudinal groove of the ramus as in that species. The surfaces preserved show that the sculpture is more marked in the *T. bilobatus* than in the *T. insignis*.

Measurements.	M.
Depth of ramus at interior edge cotylus	.026
Length " from " " "	.020
Width " at " " "	.017
" of both tuberosities of angle	.0125
Diameters of intercentrum { anteroposterior	.011
Diameters of intercentrum { transverse	.021
Thickness of intercentrum	.004

The specimens described came from the same locality, and a different one from that which has produced the specimens of the *T. insignis* (Type No. 39, 1882).

REPTILIA.

Pariotichus megalops, sp. nov.

This reptile is known to me from a nearly complete, somewhat distorted cranium. A thin layer of matrix conceals the greater number of the teeth, so that the presence of canines cannot be demonstrated. Those which are visible are on the premaxillary and anterior parts of the maxillary bones. They are small, conic, slightly curved, acute and absolutely smooth.

The muzzle is short and broadly rounded. The nareal opening is laterosuperior, and is just above the principal convexity where the lores pass into the muzzle. Canthus nostralis rounded off. Interorbital region wide, convex in section, nearly plane anteroposteriorly, its width a little exceeding the diameter of the orbit. Orbit large and round, its diameter equal to

the length of the muzzle in front of it, obliquely measured, and one-half the distance from its posterior edge to that of the temporal roof (? squamosal bone). Posterior outline of skull above, truncate, surface slightly convex transversely.

The premaxillary spines are short and wide, the nasals are also short and wide. The prefrontals and postfrontals form the superior edge of the orbit, excluding the frontals. The intercalaria (or ? pterotics) are very large; at the externoposterior angle is a very small element in contact with the supraoccipital which may be the true intercalare. The supraoccipitals have considerable transverse extent, running out externally in narrow apices. All the bones of the cranium are sculptured in honeycomb fashion, the ridges radiating on some of the bones. That is, on the posterior parts of the frontals and parietals and anterior part of the intercalare and squamosal. A groove follows the edge of the orbit, and turns inwards on the prefrontal bone, forming a rudimental lyra. External surface of mandible grooved below; superior part concealed.

Measurements.	M.
Width of skull between posterior angles	.018
Interorbital width	.008
Axial length of skull	.024
" from muzzle to between centres of orbits	.0096
Width of muzzle at nares	.0095
Length from orbit to nostril	.0035
Depth of skull posteriorly, to mandible	.010

The superior part of the posterior region of the inner face of the dentary bone supports a patch of small obtuse teeth, which narrows forwards into the single row of the edge of the ramus. This patch is no doubt homologous with that which is so largely developed in *Pantylus*.

The surface of the cranium has been mostly weathered away in the type of *Pariotichus*, *P. brachyops*, and I suspect that it is really sculptured and not smooth, as I originally stated. The *P. megalops* differs from the *P. brachyops* in the larger orbit, the narrower interorbital space, and the smaller and more numerous teeth.

Pariotichus and *Pantylus* and probably *Ectocynodon* must be referred to a special family, the *Pariotichidæ*, which has teeth like the *Edaphosauridæ** but differs from it in the entire overroofing of the temporal fossæ.

Chilonyx rapidens Cope, gen. nov.

Char. Gen.—Teeth with the long diameter of the crowns transverse to that of the jaws, and with the crown contracting to a single slightly incurved apex. Maxillary series of teeth short. Temporal fossæ overroofed. Superior surface of cranium divided into more or less swollen area by grooves.

The characters above enumerated indicate for this genus a position near the *Diadectidæ*. From these it differs in the form of the teeth, and the

* Proceed. Amer. Philos. Soc., 1882, p. 450.

short and narrow maxillary bone. Two ilia accompanying the cranium have the form of those of the *Clepsydropidæ,* and differ entirely from those of the *Diadectidæ.* On the other hand, the *foramen magnum* is wide, and the exoccipitals present two articular facets downwards as in the latter family. It is possible that the genus should be referred to the *Bolosauridæ,* which is in dentition intermediate between the *Clepsydropidæ* and *Diadectidæ.*

A femur, which is included in the lot of specimens, has a wide head without trochanters, convex in the plane of the distal condyles and flat in the direction at right angles to it. There is a huge trochanteric fossa extending from the head two-fifths the length to the condyles, bordered by a ridge on each side. The condyles present in the same direction as the fossa posteriorly. They are separated by a deep anterior and posterior emargination. Their anterior edges overhang the condylar articular surfaces, making acute angles with them. One of the articular surfaces is smaller, is anteroposteriorly extended, and has a convex ectad, and concave entad border. The other surface is also anteroposterior, reaching further distad, but not so far proximad as the other. Its area is greater than that of the other, and it is deeply notched by the entering surface of the bone ectad and proximad. It is then contracted into a wide isthmus, and the lateral grooves which produce this isthmus are overhung by the expansion of the anterior face. The anterior face of the femur is without ridges or processes.

The condition of the specimen is such that the composition of the skull may be readily made out. The postfrontal bones are large, and form the superior border of the orbit. At the front of the orbit they reach the prefontal, thus excluding the frontal. The parietal bones are wider than the frontals, and are bounded laterally by the postfrontals and the squamosals and by an element between the squamosal and exoccipital, which occupies the position of the *intercalare* of the *Stegocephali.* Below this bone, on the inner side of the suspensorium, is the probable proötic. The squamosal, or an element which I cannot distinguish from that bone, extends to the condyle of the quadrate, concealing that bone from view from externally. The quadrate is short, and thins out rapidly upwards, being closely united with the squamosal. Its condyle is set at an angle of 45° with the axes of the skull, and consists of one flat and one convex surfaces, continuous but forming a deep angle together. Exterior to the exoccipital, and interno-inferior to the intercalare, is a small distinct element, apparently in the position of an opisthotic or external occipital.

The excavation for the auditory apparatus appears to be in the exoccipital. It is almost entirely filled by what I suppose to be a large stapes. This bone is in shape like a compressed flask, with the head directed inwards and forwards, and its inferior edge produced into a prominent keel, which is produced into a point below, and free from the neck of the flask. The head is truncate, and is separated from the internal cranial wall by a narrow interspace. Its external extremity is not absolutely perfect in the specimen, but does not appear to have extended in an ossified condition be-

yond the exoccipital bone. In a specimen ot *Empedias molaris** there is a meatus auditorius, in which the stapes was not found on cleaning out. This element is coösified with the surrounding bones laterally and posteriorly. Consequently when broken open, the vestibule is represented by two deep grooves, directed inwards and anteriorly.

The single species of this genus is one of the largest saurians yet obtained from the Permian of North America.

Char. specif. The superior surface of the skull is everywhere flat, as is the external face of the maxillary. The surface of the latter is marked by moderately coarse fossæ and grooves, separated by more or less fine irregular but generally longitudinal ridges. The minute sculpture of the superior cranial surface, is finer and more punctate in character. The areæ of this surface, already mentioned, are arranged as follows: There is a series over the orbits, which are separated from each other by straight grooves, and which grow larger and more swollen posteriorly. Between these supraorbital rows, the areæ of the top of the skull are separated by longitudinal grooves, except immediately between the widths of the orbits, where there are some narrow transverse areæ. On the supraoccipital region there is a median subtriangular area, and three narrow longitudinal ones on each side of it. External to these, and on the posterior part of the squamosal region, the areæ are larger and more swollen. A cluster of three of these lies between the exoccipital bone, and the smooth descending surface of the posterior edge of the squamosal. Of these the one bounding the exoccipital bone, is a robust cone, forming a short horn, like that occupying a similar place in the horned toad, *Phrynosoma douglassi.* Between the temporal areæ, and in front of the supraoccipital areæ, on each side of the middle line, there are three longitudinal areæ, which are successively narrower externally, the exterior being very narrow. On the frontal region anterior to the transverse areæ, are two wide longitudinal areæ. Each nasal bone has a small median area, from which radiate grooves, of which some of the posterior are close together.

The occiput is excavated into a large fossa on each side of a large triangular supraoccipital region. The fossæ are bounded externally by a strong exoccipital crest and at the anteroinferior corner by the "opisthotic." This bone projects posteriorly and downwards, in the form of a robust hook. The foramen magnum is not excavated so abruptly above the exoccipital facets as in *Empedias molaris.*

Measurements of Skull and Femur.	M.
Interorbital width	.108
Length from supraoccipital crest to frontonasal suture	.135
Width between apices of tuberosities of the intercalaria	.113
Length from apex of tuberosities to inferior extremity of quadrate	.129

* Figured in the Proceed. Amer. Philos. Soc. xix. p. 56.

Measurements of Skull and Femur.		M.
Diameters of quadrate condyle	anteroposterior	.020
	transverse	.039
Length of maxillary on alveolar edge		.087
Diameters base of a posterior tooth	anteroposterior	.007
	transverse	.010
" of base of another posterior tooth	anteroposterior	.005
	transverse	.010
Length of femur		.236
Proximal diameters of femur	anteroposterior	.047
	transverse	.085
Width of shaft		.052
" distally (greatest)		.115

EMPEDIAS FISSUS, sp. nov.

The species of *Empedias* form a series which diverges from *Diadectes* in a successive widening of the crowns of the teeth and diminution in their number. Thus the *D. phaseolinus* is nearest to *Diadectes ; D. molaris* succeeds it, and in *E. fissus* we have the molariform character most strongly developed. In the *E. latibuccatus*, on the other hand, the diminution of the transverse extent of many of the teeth and the areolar sculpture of the superior surface of the cranium points in the direction of the genus *Chilonyx*. The species of *Empedias* may be easily distinguished as follows :

I. Surface of skull divided by grooves into areæ.

Superior teeth, 16 on each side, a number on each end of the maxillary bone of little transverse extent........................*E. latibuccatus*.

II. Surface of skull uniformly rugose.

Superior teeth narrower, 16 on each side, the last one small, sphenoid flat, pterygoids narrow..*E. phaseolinus*.

Superior teeth wider, 14 on each side, the last one smaller, sphenoid keeled medially, pterygoids wide..................................*E. molaris*.

Superior teeth wider, 14 on each side, the last the largest, sphenoid not keeled..*E. fissus*.

Of the *E. latibuccatus* I have two specimens with teeth, one including a large part of the cranium and lower jaw. Of the *E. phaseolinus* I have five specimens with teeth, one of which embraces a nearly complete skull and a large part of the skeleton. Of the *E. molaris* I have also five individuals, of which three are crania. The *E. fissus* is represented by two individuals. One of these is one side of the entire upper jaw ; the other is a broken skull with the four series of molar teeth. Of other parts of the skeleton, not identified as to species, I have a large number.

The *Empedias fissus* is nearest the *E. molaris*, and has the same number of teeth. It differs, however, in various essential points. The last maxillary tooth, which is much reduced in size in the *E. molaris*, is here as large as any of the others. The portion of the crown within the medium cusp is fissured medially in the direction of its length ; that is, transversely

to the axis of the jaws. This fissure is not so distinct in the mandibular teeth. The median cusp has a straight edge at right angles to the long axis of the crown. The specimen where the entire dental series of one side is preserved, shows that the latter has a sigmoid flexure, the middle of the maxillary bone being incurved, and the anterior part convex outwards. There are five or six conic teeth between the incisors and the molars.

The inferior surface of the sphenoid bone is medially flat in transverse section, and concave anteroposteriorly, in this resembling *E. phaseolinus* rather than *E. molaris*. The upper jaw specimen shows that the muzzle projects beyond the incisor teeth, which is not the case in *E. phaseolinus*, which has the incisors very prominent. The supraorbital border is regularly convex, and not depressed and notched as in *E. phaseolinus* and *E. latibuccatus*. The superior surface of the skull is marked with innumerable small impressed pits, and assumes a spongy appearance above the orbits.

Measurements.

		M.
No. 1.		
Length of last six superior molars		.055
Diameters of antepenult molar	anteroposterior	.010
	transverse	.020
Diameters of crown of incisor	vertical	.013
	transverse (at base)	.007
	anteroposterior	.011
No. 2.		
Length of dental series in a straight line		.093
Width of palate at anterior expanse		.062
" " contraction		.068
" " between widest molars		.036

Discovered by Mr. W. F. Cummins.

Empedias phaseolinus Cope, Proceeds. American Philosoph. Society, May, 1880 (*Diadectes*).

The fine specimen of this species above mentioned, which was obtained by Mr. Cummins, includes some parts of the skeleton not or rarely found hitherto. The pelvis shows that the corresponding part described by me, Proceedings of the American Philosophical Society, 1882, p. 448, belongs to another species of this group, The clavicles are preserved, and enable me to identify the corresponding part of another species in which the structure is more distinctly visible. This shows an episternum wedged in between the adjacent extremities of the clavicles, which are here very robust. But a small part of it appears in the inferior surface, but superiorly it forms a plate which covers the symphysis of the clavicles, but does not extend posterior to them. The suture of the episternum with the clavicles below is a coarse interdigitation. Posterior to it is the symphysis of the clavicles.

The skull of this specimen is the first that I have seen in this group which possesses a basioccipital bone and condyle. This proves that in the five other crania of allied species, it has fallen out, which indicates its very

weak attachment to the sphenoid. The lateral superior articular facets of the exoccipital bone are characteristic of the family, and of the genus *Chilonyx*. This skull also shows that the premaxillary bones may be distinct, and that they extend but a short distance on the superior face of the muzzle.

In this species the interorbital region is wide and concave, and the parietal regions are swollen and convex. The supraorbital border is nearly straight, and has an open notch medially.

The hyposphen varies in size in different parts of the vertebral column, and is generally very large. The neural spines have bilobate extremities.

PRINTED APRIL 17, 1883.

A. Agassiz
from the author

Paleontological Bulletin, No. 37.

ON A

New Basin of White River Age

IN DAKOTA.

Read before the American Philosophical Society, Sept. 21st, 1883.

ON THE

DISTRIBUTION OF THE LOUP FORK FORMATION

IN NEW MEXICO.

A SECOND ADDITION

To the Knowledge of the Fauna of the Puerco Epoch.

ON THE

Trituberculate Type of Molar Tooth in the Mammalia.

Read before the American Philosophical Society Dec. 7th, 1883.

By PROF. E. D. COPE.

FOR SALE BY A. E. FOOTE, 1223 Belmont Ave.,
PHILADELPHIA.

20 pp to follow

PALEONTOLOGICAL BULLETIN,

No. 37.

From Prof. E. D. Cope, a letter to the Secretary, dated Sully Springs, Dakota, Sept. 7, 1883, was read, as follows:

On a New Basin of White River Age in Dakota.

"I have the pleasure to announce to you that I have within the past week discovered the locality of a new lake of the White River epoch, at a point in this Territory nearly 200 miles north-west of the nearest boundary of the deposit of this age hitherto known. The beds, which are unmistakably of the White River formation, consist of greenish sandstone, and sand-beds, of a combined thickness of about 100 feet.. These rest on white calcareous clay, rocks and marls, of a total thickness of 100 feet. These probably also belong to the White River epoch, but contain no fossils. Below this deposit is a third bed of drab clay, which swells and cracks on exposure to weather, which rests on a thick bed of white and gray sand, more or less mixed with gravel. This bed, with the overlying clay, probably belongs to the Laramie period, as the beds lower in the series certainly do.

"The deposit as observed, does not extend over ten miles in north and south diameter. The east and west extent was not determined, but is much greater.

"The fossils, which indicate clearly the age of the formation, are the following:

PISCES.

Rhineastes, sp. nov.	}	2
Amiurus, sp. nov.	}	

LACERTILIA.	
Sp. indet	1
TESTUDINATA.	
Trionyx, sp	3
Trionyx, sp	
Stylemys, sp	
RODENTIA.	
Castor, sp	2
CARNIVORA.	
Galecynus gregarius	3
Hoplophoneus, sp	
? Hoplophoneus	
PERISSODACTYLA.	
Aceratherium, sp	3
Aceratherium, sp	
Anchitherium, sp	
ARTIODACTYLA.	
Elotherium ramosum	7
Hyopotamus sp	
Oreodon, sp	
Oreodon, sp	
Oreodon, sp	
Leptomeryx, sp	
Hypertragulus, sp	
Total species	21

"Interesting features of the above catalogue are: The absence of Hyracodon and Poëbrotherium, so abundant in the beds of this age elsewhere; the presence of fishes, not hitherto detected in them; and the presence of the genius of tortoises, *Trionyx*. The latter genus has not hitherto been found in our Western lacustrine beds of later than Eocene age; while they are abundant in our modern rivers. This discovery partially bridges the interval. The same is true of the fishes mentioned, which represent the order Nematognathi."

On the distribution of the Loup Fork formation in New Mexico. By E. D. Cope.

(Read before the American Philosophical Society, December 7, 1883.)

In his report on the Geology of New Mexico to the Secretary of the Interior, by Dr. F. V. Hayden, in 1869, this eminent geologist described the Santa Fé marls in their principal physical features. In 1874, in my report to Capt. George M. Wheeler, U. S. Engineers, I showed that this formation is a member of the Loup Fork division of the Miocene Tertiary, a conclusion clearly deducible from the remains of vertebrata which it contains. An illustrated report on the latter was published in the fourth volume of the report of the United States Geographical and Geological Survey, W. of the 100th meridian, Capt. G. M. Wheeler in charge(1877).

Since that time the writer has made several visits to parts of New Mexico not previously explored, and I am able to show that the Loup Fork formation has a much wider distribution in that Territory than has hitherto been supposed to be the case.

In descending the Rio Grande, beds appear on the west side of the river, which strongly resemble those of Santa Fé. They extend along the eastern base of the Magdalena mountains, and as far south as Socorro, in considerable extent and thickness. South of Socorro they appear, but less extensively. The eastern part of the plain which lies between the Rio Grande and the Mimbres mountains is composed of beds of this age where cut by the grade of the Atchison, Topeka and Santa Fé railroad, west of Hatch station. West of the Mimbres mountains the valley of the river of the same name is filled with débris of the bed of eruptive outflow which once covered the country, as far as traversed by the railroad from Deming to Silver City. Its age I could not ascertain.

A great display of the Loup Fork formation is seen in the drainage basins of the heads of the Gila river. In traveling westward from Silver City, its beds first appear in the valley of Mangus creek, which enters the Gila from the east. Crossing the Gila, the mail route to the west passes through the valley of Duck Creek, which flows eastwards into that river. Though bounded by eruptive hills and mountains and their outflows, the valley was once filled with Loup Fork beds, which have been extensively eroded, the principal exposures being on the north side of the valley, forming the foot hills of the Mogollon range. On the divide between the waters of the Gila and San Francisco rivers the formation rises in bluffs of 300 feet elevation. The descent into the valley of the San Francisco brings to light a still greater depth of this deposit. The valley which extends from the canyon which encloses the river south from the mouth of Dry creek to the Tulerosa mountains on thenorth, and between the Mogollons on the east and the San Francisco range on the west, was once filled with the deposit of a Loup Fork lake. This mass has been reduced by the erosive action of the San Francisco and its drainage, to a greater or less

extent, as it has been protected by basaltic outflows or not. When so protected, the river flows through comparatively narrow canyons. Where the outflow is wanting, the valley of the river is wider, and the Loup Fork formation remains as wide grassy mesas which extend to the feet of the mountain ranges.

The age of these beds would have remained problematical but for the fortunate discovery by Mr. Robert Seip, of the skull of a species of Rhinoceros of the typical Loup Fork genus, Aphelops. It is apparently the *A. fossiger* Cope, a species abundant in the Loup Fork beds of Kansas and Nebraska. It was found near the mouth of Dry creek in a conglomerate bed of the formation.

In the valley of the San Francisco the Loup Fork beds reach a thickness of 500 feet, and consist of sand, clayey sand, soft sandstone, and conglomerates of larger and smaller pebbles of eruptive material, having a near resemblance to those of the region of Santa Fé.

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*Second Addition to the Knowledge of the Puerco Epoch. By E. D. Cope.**

(Read before the American Philosophical Society, December 7, 1883.)

Recent collections from the formation above-named, include many finer specimens than have been previously obtained. Skulls of several species in calcareous concretions were received, so that their characters can be developed more fully than heretofore. I mention especially *Deltatherium fundaminis ; Periptychus rhabdodon* and *P. coarctatus ; Haploconus lineatus ; H. entoconus ; Anisonchus sectorius ; Protogonia plicifera ; Mioclænus turgidus, M. ferox, M. subtrigonus* and *M. cuspidatus*, sp. nov. Some species hitherto rarely seen, prove to be abundant, as *Hemithlæus kowalevskianus, Protogonia plicifera, Mioclaenus minimus* and *M. subtrigonus.* With the additional species now described, the number of Mammalia from the deposit of the Puerco epoch amounts to seventy-four species.

Didymictis primus, sp. nov.

That the genus Didymictis existed during the Puerco epoch, has been already demonstrated by the discovery of the *D. haydenianus* Cope. This species is of aberrant form however, so that it remained to prove that the typical form had appeared so early in Tertiary time. This is now shown to have been the case by the discovery of the present animal, which is allied to the *D. leptomylus* of the Wind river and Wasatch epochs.

The *Didymictis primus* is known from two maxillary bones with teeth,

*The "First addition" appeared in the Proceedings of the American Philosophical Society for 1883, beginning at page 545. Since that date I have described in the Proceedings of the Philadelphia Academy, 1883, p. 168, the following species: *Periptychus coarctatus, Pantolambda cavirictus, Zetodon gracilis* (g. n.) and *Conoryctes ditrigonus.*

and a part of a mandibular bone with the last two molars in place, all belonging to different individuals. The inferior sectorial tooth is much like that of the *D. leptomylus*, but the tubercular is only two-thirds as long, and is not only absolutely, but relatively narrower posteriorly. It has the usual three cusps in a reduced condition. In the first superior true molar the external cusps are conical, and there is a small cusp between the anterior one and the produced anterior angle of the crown. There is an anterior intermediate tubercle, but no posterior one. The cingulum does not extend all round the inferior base of the crown, as it does in *D. protenus*. The sectorial has a distinct anterior basal conic lobe. The internal lobe is in transverse line with the last named, and is conical and not large.

Measurements.		M.
Diameter inferior sectorial	anteroposterior	.0138
	transverse	.0055
Diameter inferior tubercular	anteroposterior	.0050
	transverse	.0033
Depth of ramus at M. i		.0098
Diameter superior sectorial (No. 1)	anteroposterior	.0110
	transverse	.0060
Diameters superior sectorial (No. 2)	anteroposterior	0050
	transverse	.0090

The fourth specimen is especially important as presenting almost the entire dentition including canines and incisors, and the anterior part of the skull from the line of the coronoid process of the mandible. The specimen shows that the species differs from the species of the Wasatch period with oval inferior tubercular, in the absence of the posterior cutting lobe of the third, and probably fourth inferior premolar. The corresponding superior premolars are also simple. The first premolars in both jaws are one-rooted. The canines are long and acute, and are directed vertically. Both have flat facets on their external (the only visible) faces: on the superior canine I count four lateral, and one nearly anterior. On the inferior I see three lateral and one nearly anterior. There are three small superior incisors, of which the first is the largest, and has a subconical crown. The infraorbital foramen is large, and is above the anterior border of the superior sectorial.

Measurements.	M.
Length of superior dental series to front of canine	.041
" " crown of superior canine	011
" " superior true molars	.0105
Depth of ramus at inferior sectorial	.0090

In its simple premolars this species agrees with the *D. haydenianus*, and is more primitive than the Wasatch species.

TRIÏSODON RUSTICUS, sp. nov.

Founded on a portion of the mandible which supports the first two true molars and part of the last premolar. The species is of the type of *T.*

levisanus, but is much larger. I give here a synopsis of the species of the genus, so that its affinities may be better understood. In general, the genus *Triisodon* is characterized by the rudimental character in the inferior molars of the anterior cusp. It is thus like *Ictops,* but differs in having the fourth premolar different from the true molars and like the premolars. From *Mioclænus* it differs in having the anterior and posterior cusps of the inferior molars unequal; the anterior forming together an elevated crest with two apices, while the posterior are low, and on the borders of a heel.

I. Cusps of inferior molars compressed.
Anterior cusp very low.................................. *T. quivirensis.*
II. Cusps of inferior molars not compressed.
Anterior cusp very low; *T. rusticus; T. levisanus,* and *T. assurgens.*
Anterior cusp as high as other anterior cusps to which it is closely united.
T. conidens and *T. heilprinianus.*

In dimensions the *T. rusticus* is about equal to the *T. quivirensis,* thus exceeding the other species excepting the *T. conidens.* The interior anterior cusp is nearly as elevated as the exterior, and is united with it nearly to the apex; the anterior cusp is a tubercle which projects forwards from its anterior base. The heel of the tooth is wide, and is rounded posteriorly, and supports three tubercles, an external, a posterior and an internal, all in contact with each other. On the second true molar the internal anterior tubercle presents a slightly projecting edge anteriorly and posteriorly, which bounds a shallow vertical groove of the mass which represents their united bodies. This is not apparent in the first. The enamel is smooth, but the animal is rather old.

Measurements.			M.
Diameters of m. i	anteroposterior		.0123
	transverse		.0068
	vertical	in front	.0068
		at heel	.0038
Diameters of m. ii	anteroposterior		.0137
	transverse		.007
	vertical	anteriorly	.007
		at heel	.0062

D. Baldwin, discoverer.

Triïsodon assurgens, sp. nov.

This is the least species of the genus, and resembles in its inferior dentition the species of *Diacodon.* It is very much larger than the *D. alticuspis,* the larger species of that genus, which is found in the Wasatch formation.

The *T. assurgens* is known from a mandibular ramus which supports the last four molars, the last premolar having lost its principal cusp. The peculiarity of the true molars is seen in their generally more produced character; the anterior cusps are higher and the heels are longer. The anterior cusp is very small and basal; the principal anterior cusps are united

to near their free summits. There are the usual low marginal tubercles on the heels. That of the fourth premolar is a short simple edge.

Measurements.	M.
Length of four molars on basis	.028
" " three true molars	.0212
" " second true molar	.008
Elevation of cusps of molars	.0045
Length of last true molar	.0067
Width of last true molar	.0030
Elevation of last true molar in front	.0035

Found by D. Baldwin.

MIOCLÆNUS CUSPIDATUS, sp. nov.

The species of this genus known to me are, with the present one, nine in number. They range in size from that of a rat (*M. minimus*) to that of a wolf (*M. ferox*). The general osteological characters of the last named species are best known, and are described in the Proceedings of the American Philosophical Society, 1883, p. 547. In two of the species the superior dental series only is more or less known, and one species rests on mandibular dentition only. In the remaining seven species the dentition of both jaws is more or less known. The species may be arranged in groups as follows :

I. The posterior heel of the second inferior molar bordered by a curved edge or crest.

a. Posterior cingulum of superior true molars obsolete ; *M. minimus.*

aa. Posterior superior cingulum weak ; *M. turgidus.*

aaa. Posterior superior cingulum large, angulate ; *M. corrugatus ; M. ferox.*

II. The posterior heel of the second inferior molar supporting a cusp.

a. Posterior inner cusp of superior molars small, present on m. ii only ; *M. cuspidatus.*

aa. Posterior inner cusp large, present on m. i and m. ii; premolars small, *M. subtrigonus ;* premolars large, *M. opisthacus* (*Hemithlæus mihi olim*).

III. Second lower molar unknown. *M. protogonioides,* and *M. mandibularis.*

The supposed *M. baldwini,* resembles closely the species of *Hemithlæus.*

It is probable that two genera are here included under the head of *Mioclænus.* If the character is permanent, these will be distinguished as follows :

Third superior premolar with internal tubercle................*Mioclænus.*
Third superior premolar without internal tubercle............*Oxyclænus.*

The species of *Mioclænus* are *M. turgidus* (type) ; and very probably *M. opisthacus, minimus* and *M. subtrigonus* ; but the diagnostic tooth has not been seen in them as yet. The species of *Oxyclænus* are : *O. cuspidatus*

and *O. corrugatus*; and very probably, *O. ferox*. The position of the *M. protogonioides*, *M. baldwini* and *M. mandibularis* is uncertain, though the last two are probably *Oxyclæni*.

The *Mioclænus cuspidatus* is distinguished among its congeners, by the transverse character of its superior molar teeth, that is, by the relatively smaller anteroposterior diameter as compared with the transverse; and by the prominence and acuteness of their principal cusps. They thus stand at the opposite extreme of the genus from the *M. turgidus*, where the teeth are characterized by the robustness and obtuseness of the cusps, although in the triangular basis of the second superior molar they agree. The external cusps are compressed cones, and in contact at the base; the intermediate tubercles are small and distinct. The internal cusp is large and prominent. The base of the fourth premolar is T-shaped, and is as long as wide. Its internal and external cusps are well developed. The cingulum of the true molars is complete all round on the last one, and on the two others except at the internal base, where it is interrupted. The second molar only displays a posterior inner tubercle of the cingulum, which is small, and does not give a truncate interior outline of the crown, characteristic of *M. opisthacus*, *M. ferox*, etc. On the ms. i and ii, the cingulum is expanded at the external angles of the crown, most so anteriorly. The anterior expansion rises in a low cusp in the P-m. iv. The enamel is smooth.

This species need only be compared with *M. opisthacus* and *M. subtrigonus*, which are of about the same size. Passing by the differences already mentioned in the table, the fourth premolar has a different form from that of the *M opisthacus*. In the latter it is narrower and more transverse, and with larger conical cusps, much as in *M. turgidus*; in the present species it has the trilobate outline seen in *M. subtrigonus*. As to the latter species, the teeth are wide, and the cusps smaller and separated at at the base, and the cingulum is crenate and lobate, in a manner quite different from the smoothness and compactness of structure seen in the *M. cuspidatus*.

Measurements.		M.
Length of base of last four superior molars		.026
" " " three true molars		.019
Diameters of P-m. iv	anteroposterior	.006
	transverse	.004
Diameters of m. i.	anteroposterior	.006
	transverse	.006
Diameters of m. ii	anteroposterior	.0064
	transverse	.008
Diameters of m. iii	anteroposterior	.0045
	transverse	.006

D. Baldwin, discoverer.

CHRIACUS TRUNCATUS, sp. nov.

The genus *Chriacus* m. was characterized in the Proceedings of the

Academy of Philadelphia, 1883, p. 80, and two species were mentioned, *C. pelvidens* (type) and *C. angulatus*. The former of these is from the Puerco, the latter from the Wasatch formation ; the former is the larger species ; the latter quite small. I now add two species to the genus which are intermediate in dimensions between those already known.

I. Posterior cingulum of superior molars with large tubercle.

Large species ; *C. pelvidens ;* small species, *C. truncatus.*

II. Posterior cingulum with small tubercle ; small species ; *C. angulatus.*

III. Posterior ciugulum without tubercle ; small species ; *C. simplex.*

In the *C. truncatus* the posterior singular (inner) tubercle reaches the largest development, but is not present on the cingulum of the last superior molar. The anterior cingulum is weak on that tooth and on the first true molar, but on the second it is thickened into a small anterior or inner tubercle. This with the posterior inner gives the crown a truncate internal outline, as is also the case in the *C. pelvidens.* The intermediate tubercles are distinct, and the external cusps are separate at the base. An external cingulum. The fourth premolar has a triangular base ; a single compressed external cusp, and a small acutely conical internal one. The internal tubercle is small and acute on the third premolar. The second premolar is small and probably one-rooted, and it is possible that there is no first premolar. The canine is directcd vertically downwards, and the base of the crown is oval.

Besides the considerably smaller size, the posterior internal cusps are relatively larger than in *C. pelvidens.*

Measurements.		M.
Length of superior dental series including canine		.039
Length of true molar series		.014
Diameters P-m. iii	anteroposterior	.004
	transverse	.003
Diameters P-m. iv	anteroposterior	.004
	transverse	.005
Diameters M. ii	anteroposterior	.005
	transverse	.0064
Diameters m. iii	anteroposterior	.0033
	transverse	.005

Two individuals from New Mexico. D. Baldwin.

CHRIACUS SIMPLEX, sp. nov.

This species is represented by a part of the left maxillary bone, which supports the true molars except a part of the last one ; and by parts of the mandible, with the first and second true molars, and perhaps one of the premolars. The true molars are about the size of those of the *C. truncatus,* but of very different detailed structure, as already pointed out. The posterior cingulum is stronger than the anterior, but does not support a trace of a cusp, and they do not unite on the inner face of the crown. External

cingulum present. External cusps rather small, separate. Intermediate cusps present ; V large and distinct. Enamel smooth.

The inferior true molars support Vs; in the second the anterior is smaller and is more elevated than the posterior. The latter is continued as a raised posterior, and partly interior border of the heel, without prominent cusp. The crown has a distinct external and a very faint internal cingulum. In the supposed first true molar, the anterior V is more prolonged anteroposteriorly as in the corresponding tooth of *Mioclænus ferox*, etc., and the fourth premolar of *Phenacodus primævus*. The anterior cusp is the lowest. The heel supports three low cusps, of which the external has a crescentic section, and the posterior is the smallest.

It is probable but not certain that the fourth premolar has an internal cusp, as the tooth, presumably this one, is injured at that point, Should the internal cusp be absent, this species cannot be referred to *Chriacus*.

Measurements.		M.
Length of superior true molars		.0135
Diameters of first true molars	anteroposterior	.005
	transverse	.006
Diameters of second true molars	anteroposterior	.0053
	transverse	.007
Diameters of third true molar	anteroposterior	.0034
	transverse	.006
Diameters of first inferior true molar	anteroposterior	.005
	transverse	.0035
Diameters of second inferior true molar	anteroposterior	.0056
	transverse	.0043

D. Baldwin, discoverer.

TRICENTES CRASSICOLLIDENS, gen. et sp. nov.

Char. gen. This genus is *Chriacus* with only three premolars in the superior, and probably inferior series. The canines are well developed, and lateral in position, leaving space for small incisors, thus differing from the genera of the *Mixodectidæ, Mixodectes, Microsyops*, and *Cynodontomys*, on the one hand, and from *Necrolemur* on the other. It has, so far as known, the dental formula of several genera of typical Lemuridæ, but differs from these in the following points. The orbit is open posteriorly ; the inferior molars have the anterior triangle of three cusps ; and the fourth inferior premolar has an interior cusp. I have demonstrated the last mentioned characters on the type, *T. crassicollidens* only, but suspect its presence on some or all of the other species. In their details the superior true molars are like those of Mioclænus, as distinguished from those of Pelycodus.

To this genus belongs the *Mioclænus subtrigonus*, and probably, from the small size of its fourth premolar, the *M. bucculentus*. I add to these three a fourth, *T. inæquidens*, and remark that it is yet uncertain how many premolars are present in the *Chriacus simplex*. Should the latter possess three only, it will be properly referred to Tricentes.

These species differ as follows :

I. Posterior cingulum of true molars i and ii, wide, rising into a small cusp.

Length of true molars, M. .0155........................... *crassicollidens.*

II. Posterior cingulum distinct, thickened inwards.

Length of true molars (m. ii inferential) .0175, crowns narrowed, transverse.. *bucculentus.*

Length of true molars .0170 ; crowns quadrate.............. *subtrigonus.**

Length of true molars .0135 ; crowns narrowed, transverse.............. (*Chriacus*) *simplex.*

III. Posterior cingulum weak, disappearing inwards.

Length of true molars .0105, crowns transverse except the third, which is very small.. *inæquidens.*

Char. Specif. The *Tricentes crassicollidens* is about the size of the *Chriacus truncatus* and resembles it a good deal. The latter has, however, a more transverse form of true molars, as compared with the present species, where the form is subquadrate. In the present animal the premolars are smaller, and if the third (second present) has an internal cusp, it is much more insignificant than in the *C. truncatus.* These two species and the *Mioclænus opisthacus* resemble each other in the similar size, and in the true molars having the posterior inner cusp more distinct than in other species. They differ in the dimensions of their premolars, those of the *M. opisthacus* being the largest, and those of *C. truncatus* being intermediate in size. In the *T. crassicollidens* the anterior cingulum is also distinct. The external cusps are conic, and are well separated, and the internal V is distinct. The internal cusp of the fourth premolar is small and compressed, so as to be transverse. The base of the third premolar is triangular and much longer than wide. All the superior molars, except the first premolar, are furnished with an external cingulum, which rises into a more or less distinct apex at its anterior and posterior angles. The first premolar is a simple cone. The alveolus of the canine tooth is of large size. The last true molar is not much reduced, and the first is as large as the second. This is not the case with the *T. bucculentus,* where the first is considerably smaller than the second.

Measurements.		M.
Length of dental series to canine, exclusive		.036
" " diastema		.006
" " premolar series		.0143
" " true molar series		.0152
Diameter of P-m. iv	anteroposterior	.0042
	transverse	.0042

* There may be two species confounded under this name. A specimen figured in Vol. III of the final (4to) Report of the Hayden Survey, Plate XXIV, f, fig. 4 has four inferior premolars, all simple.

Measurements.		M.
Diameter of M. i	anteroposterior	.0058
	transverse	.0050
Diameter of M. iii	anteroposterior	.0030
	transverse	.0048

A pair of mandibular rami, found on the same day, and at or near the same place, probably belong to the same species, if not to the same animal, they support all the teeth, but only the P-m iv and the M. i and ii have yet been disengaged from the matrix. The P-m. iv is rather large and robust, and has a short wide heel, and an anterior cusp which leaves the main cusps half way to the apex, or at the same elevation as the internal cusp. The anterior three cusps of the true molars are elevated above the heel, and the anterior is nearly median, forms no blade with external anterior, and is smaller than the anterior internal cusp. The heel is well developed, and its borders rise in two obtuse open Vs, whose apices look away from each other. The internal supports two cusps, the external, but one. No cingula ; enamel smooth.

Measurements of inferior teeth.		M.
Diameters of P-m. iv	anteroposterior	.0060
	transverse	.0035
Diameters of m. ii	anteroposterior	.0050
	transverse	.0039
Length of bases of m. i and m. ii		.0110

From Upper Puerco ; D. Baldwin.

TRICENTES INÆQUIDENS, sp. nov.

This species is represented by two mutilated crania, obtained on the same day and near the same locality as the preceding species. One of these, which I select as type, embraces the muzzle and palate anterior to the posterior border of the maxillary bone.

Besides its inferior size, other characters distinguish this species. The simplicity of the superior molars is seen in no other, and the very reduced size of the third superior molar is not found in any of its allies. This is correlated with an oblique reduction of the maxillary bone behind, which gives the second true molar an oblique external border instead of the longitudinal one seen in the other species. The external cusps of the molars are conic, and are not in contact at the base. The internal cusp is also conic, and is larger than the external. The internal cusp of the fourth premolar is large. It is probable that the third premolar supports an internal cusp, as the crown base is as wide as long. The premolars are spaced in this species, as in the last, but the diastema is shorter than in the *T. crassicollidens*, not exceeding the premolar interspaces. The external cingulum is quite weak. The canine alveolus is large. The incisors are wanting, but the premaxillary region is wide. The inferior dentition is unknown.

Measurements of superior teeth.		M.
Length of dental series, including canine		.0272
" from canine to m. i, exclusive		.0130
Length of true molar series		.0100
Diameter of P-m. iii	anteroposterior	.0028
	transverse	.0025
Diameters of P-m. iv	anteroposterior	.0030
	transverse	.0042
Diameters M. i	anteroposterior	.0038
	transverse	.0048
Diameters M. ii	anteroposterior	0039
	transverse	.0059
Diameters M. iii	anteroposterior	.0015
	transverse	.0024

Upper Puerco ; D. Baldwin.

INDRODON MALARIS, gen. et sp. nov.

Char. gen. Family Anaptomorphidæ, suborder perhaps Lemuroidea, as indicated by the dentition only. It differs from *Anaptomorphus* in three points. First, there are three superior incisors ; second, the first (third) premolar has no internal lobe ; and third, there is a distinct posterior internal tubercle on the first and second superior molars.

The animals of the Eocene period of the family of the *Adapidæ,* may belong to the *Lemuroidea,* but the evidence which I have derived from the feet of *Pelycodus** has led me to refer them† to the Insectivorous division of the Bunotheria, to the neighborhood of the Tupæidæ and Erinaceidæ. At the same time I retained provisionally the genera with three and two superior premolars in the suborder Lemuroidea, although the foot structure of these extinct genera is yet unknown. I also indadvertently defined the Lemuroidea as having quadritubercular superior molars, a character which I well knew to be wanting in various extinct and recent genera where they are tritubercular. Two families were proposed† for the Eocene lemuroids, which are defined as follows :

Superior premolars three .... *Mixodectidæ.*
" " two .... *Anaptomorphidæ.*

The genera of the first named family are defined as follows :

I. Canine teeth large and lateral, well separated.

First superior premolar without internal lobe ; superior true molars tritubercular with cingula .... *Tricentes.*

II. Canine teeth median in position or much reduced in size.

α. Last inferior premolar without internal tubercle.

Inferior premolars all one-rooted ; canine and incisor small. . *Necrolemur.*‡

*Report of U. S. G. G. Survey W. of 100th Mer. G. M. Wheeler, iv, p. 140.
†Proceedings Academy Natural Sciences, of Philadelphia, 1883, p. 78–80.
‡Filhol Rech. Phosph. Quercy.

First premolars only one-rooted ; canine small ; incisor very large..*Mixodectes.**

aa. Last inferior premolar with internal tubercle.

A very large ? canine ; first premolar only, one-rooted.......*Microsyops.*†

A very large ? canine ; first and second premolars both one-rooted..*Cynodontomys.*‡

The genera of Anaptomorphidæ, which on dental characters includes *Indrodon*, differ as follows :

a. Incisors three.

First superior incisor without inner lobe ; posterior inner tubercle present on first and second tubercle...............*Indrodon.*

aa. Incisors two.

First superior incisor with inner lobe ; no posterior inner tubercle on superior molars ....*Anaptomorphus.*

The superior dental formula of *Indrodon* is I. $\frac{3}{}$; C. $\frac{1}{}$; P-m. $\frac{2}{}$; M. $\frac{3}{}$. The canine is compressed and acute ; the third premolar is compressed conic, and has two roots. The fourth premolar has but one external cusp. The external cusps of the true molars are conic and acute, and are connected with the internal cusp by ridges which form a V. Posterior inner cusp distinct on ms. i and ii, a part of the posterior cingulum. Intermediate tubercles present, small. The superior incisors are well developed, and display no tendency towards the rodent type. A portion of lower jaw adheres to the skull, and may belong to the same animal. It supports the last two molars. These have two anterior, opposite, approximated cusps. The heel of the penultimate molar is rather large, and has a raised edge, which develops low tubercles at the angles.

Char. Specif. The first and third superior incisors are a little larger than the second. Canine preceded and followed by diastemata, each of which is 1.5 times as long as the long diameter of the base of the crown. Premolars separated from each other and from the first true molar by interspaces half as long as the diastema. Neither tooth has any basal tubercles, but the posterior has a weak external cingulum, which is stronger posteriorly. The internal cusp of the same tooth is anterior, is acute and elevated. The superior true molars have a strong external cingulum, which rises into a small tubercle opposite the space between the external principal cusps. Of the latter, the anterior is a little more conic than the posterior, and both are well within the external border. On the last molar, the posterior external cusp is continuous with the external intermediate tubercle, and forms a cutting edge within the posterior margin of the crown. The posterior inner tubercle is rather large, and projects further inwards than the apex of the anterior V on the second true molar, but not so far as in the species of *Anisonchus* and *Haploconus.*

*Proceedings American Philosophical Society, 1883, p. 559.

†Leidy Report U. S. Geol. Survey, Terrs. I.

‡Cope, Pal. Bull., No. 34.

The surface of the cranium is too much obscured by cracks and films of matrix to permit a view of the sutures and foramina. The face is wide, as the posterior part of the maxillary and the malar bone are expanded outwards. I have not yet been able to ascertain the condition of the orbit posteriorly. The mandibular ramus is rather slender.

Measurements.		M.
Length of dental series from posterior base of i iii		.0248
" " bases of superior incisors		.0060
" from i iii to P-m. iii, exclusive		.0074
" of premolars on maxillary bone		.0060
" " base of P-m. iii		.0020
" " P-m. iv		.0028
Width " "		.0038
Diameters m. i	anteroposterier	.0030
	transverse	.0032
Diameters m. ii	anteroposterior	.0033
	transverse	.0040
Diameters m. iii	anteroposterior	.0030
	transverse	.0040
Diameters inferior m. ii	anteroposterior	.0032
	transverse	.0030
Depth of ramus mandibuli at m. ii		.0070

The skull is about the size of that of the *Bassaris astuta.* D. Baldwin, discoverer.

The discovery of this type in the Puerco formation is a fact of interest. In the shortening of its dental series it is the most specialized genus of the epoch, while the forms of its true molars are like those of the simpler Creodonta, and more specialized than those of *Anaptomorphus,* and the lemurs generally. In the simplicity of its premolars, however, it maintains the general character of the Puerco fauna, and is more primitive than the forms just named. Its nearest ally of the Puerco yet known is *Chriacus.*

ANISONCHUS AGAPETILLUS, sp. nov.

This species is founded on parts of six mandibular rami, none of which has more than four continuous molars in position, including the last. It is not entirely certain that these belong to a species of *Anisonchus,* because the superior molar teeth by which that genus is distinguished from *Haploconus* and *Hemithlæus,* are wanting. The inferior molars have the anterior inner cusp moderately well developed, as in *Anisonchus gillianus.*

The crowns of the true molars consist of two Vs; of which the posterior base of the posterior one, is rendered irregular by the presence of a small posterior median tubercle. Of the anterior pair of cusps, the external is a little the more elevated, and the internal is more elevated than any of the posterior ones. The internal posterior as well as the external posterior

cusp has a V-shaped section, because its anterior border is continued as an oblique ridge to the base of the anterior internal cusp. Internal cingula none; a slight one on the external base of the large anterior external cusp. The heel of the third true molar is well developed, and rises into an acute cusp. That of the fourth premolar is short and flat. The anterior cusp of the same is basal and rudimental. This tooth is not enlarged as is usually the case in the *Periptychidæ*, and it first here differs from these animals, and agrees with the unguiculate types in that its lateral faces are unequally convex.

Measurements.	M.
Length of last four molars on base	.014
" " fourth premolar	.0035
Elevation of " "	.0038
Length of second true molar	.0031
Width " " " (greatest)	.003
Length of third " " "	.004
Width " " " "	.0028
Depth of ramus at second true molar	.007

Anisonchus cophater, sp. nov.

A mandibular ramus supporting three molars, two of them true, is all that I have seen of this species. Its proportions are the same as those of the *A. agapetillus*, that is, much smaller than the *A. gillianus*, and the single premolar is much more like that of other species of the genus. The true molars differ from those of the *A. agapetillus* in two strong characters. First, the internal posterior cusp is inside the rim of the heel of the crown, that is, outside the bordering edge, and is therefore very distinct from the posterior median cusp. It is a sharp cone; secondly, there is a cingulum extending from this cusp round the internal base of the internal anterior cusp. There is also one at the base of the external anterior cusp, which continues to the heel only on the last inferior molar. The posterior heel is relatively wider, and the anterior V relatively more contracted, than in the *A. agapetillus*. The anterior tubercle is moderately developed at the anterior base of the anterior V. The third or fourth premolar is equilateral, and larger than the true molars. It has a short apiculate heel, and a rudimental anterior basal tubercle.

Measurements.			M.
Diameters of m. ii	horizontal	anteroposterior	.0032
		transverse	.0030
	vertical	anterior	.0025
		posterior	.0013
Diameters of P-m. iii or iv		anteroposterior	,0043
		vertical (restored apex)	.0040
		transverse	.0023

D. Baldwin, discoverer.

Chirox plicatus, gen. et sp. nov.

Char. gen. These are known from three superior molars; viz: the last

premolar, and the second and third true molars. The fourth premolar has two external, and one internal cusps, and the true molars have four cusps each. The cusps are of peculiar form. The second true molar resembles a convex body which has been divided by two cuts at right angles to each other, from which the quarters thus produced has spread away from each other subequally. The external faces of the cusps are convex. The apices are acute. The last superior molar is larger anteroposteriorly than transversely. The fourth premolar (supposed) is two-rooted.

These molar teeth remind one of the inferior molars of *Ptilodus*, through they differ much from them. The genus is probably nearer to *Catopsalis*, and belongs to the Marsupial order. The presence of only two series of cusps in the superior molars, distinguishes it from these genera, which have presumably three series of such cusps. Lemoine has shown this to be the case in *Neoplagiaulax*.

Char. specif. The external cusps of the fourth premolar are flattened on the external side, and lean a little inwards. The internal cusp (probably homologically the anterior) is opposite the anterior external, and has a convex internal face. Its apex is acute and compressed; the apices of the external cusps are trihedral and acute.

The cusps of the second true molars are more widely separated transversely than anteroposteriorly; that is, the longitudinal fissure is wider than the transverse. The apices are all acute, the internal trihedral, the external more compressed.

The transverse diameter of the last true molar is smaller than that of the second true molar, while the longitudinal is nearly the same. The crown projects convexly posterior to the posterior pair, and there is a small tubercle at the anterior base of the external anterior cusp.

None of the teeth preserved display cingula. The bases of the crown are smooth, but the cusps are sharply and finely parallel-grooved on their external faces.

Measurements.		M.
Diameters of P-m. iv	anteroposterior	.0030
	transverse	.0038
Diameters of m. ii	anteroposterior	.0033
	transverse	.0035
Diameters of m. iii	anteroposterior	.0035
	transverse	.0030

D. Baldwin, discoverer.

CATOPSALIS FISSIDENS, sp. nov.

This Marsupial is represented by a portion of the lower jaw which supports the molar teeth. The first, which is probably the fourth premolar, is represented only by its single root, which fills a round alveolus near the anterior base of the first true molar.

In size this species is intermediate between the small *C. foliatus* and the large *C. pollux.* The first molar is the longer and narrower, and the

second the shorter and wider, as in the known species. The first molar differs from that of both the latter, in having the tubercles of one side separated nearly to the base. These tubercles are conic, and not flattened as in *C. foliatus* and *C. pollux*, and the two rows are separated by a distinct valley, as in the first named. There are five tubercles on one side, and four on the other side of the crown, and in addition, two small cusps at the anterior extremity of each row, and another at the posterior extremity of one of the rows. These additional cusplets are not present in the other species.

The last molar is relatively wider than in the other species. Its crown is a good deal worn, but there are probably more than two rows of tubercles, as there are some appendicular rows on one side of the crown at least.

Measurements.		M.
Diameters M. i	anteroposterior	.0135
	transverse	.0050
Diameters M. ii	anteroposterior	.0090
	transverse	.0075

The Upper Puerco ; D. Baldwin.

General remarks on the characters of the Mammalia of the Puerco Epoch.

I have already called attention to the fact that the Mammalia of the Puerco epoch possess, with but few exceptions, superior molar teeth whose crowns include only three of the component tubercles of the normal mammalian molar, in a condition of full development.* In the number of species of supposed placentals now known, sixty-seven, the proportion of species (1), with quadrituberculate superior molars is even smaller, being only four to sixty-three. The premolars display equally primitive characters, and to these I wish now to draw attention.

2. The presence of two internal tubercles of the fourth superior premolar is unknown as yet in the fauna.

3. The presence of two external cusps of the same tooth is known or inferred in only five species in the sixty-seven, and in two of the five it is of reduced size.

4. The presence of one internal cusp of the fourth superior premolar is demonstrated or inferred in all of the placental species.

5. The presence of the internal cusp of the third superior premolar is, on the other hand, only demonstrated in twenty-two species. In seventeen it is wanting.

Referring to the inferior premolars :

6. No species presents an internal cusp of the third premolar.

7. An internal cusp of the fourth premolar is present in only fourteen species. In twenty-nine species it is certainly wanting.

* Proceedings of the American Philosophical Society, 1883, 562. American Naturalist, 1883, 407.

8. In no species of this formation is the fourth inferior premolar like a molar tooth.

It is thus evident that the dentition of the mammalia of the Puerco fauna presents a much greater degree of simplicity than does that of the species of any of the later Eocene or other age. This result coincides with the results I have already obtained from a study of the structure of the feet, etc.* These may be summarized again as follows:

1. The species in which the number of toes is known, have them 5–5.
2. Those in which the feet are known are plantigrade.
3. No species is known to have interlocking carpal and tarsal bones, excepting the two species of *Pantolambda* (carpus unknown).
4. No species is known to have well grooved astragalus (its presence is inferred in two species of *Dissacus*).
5. No species is known to have a faceted radius or ulno-radius, adapted to the separate carpal bones of the proximal row.
6. In no species is the tongue in the metapodio-phalangeal joints developed on the front of the metapodial bones.
7. The zygopophyses where known are all flat, except in some species (probably all) of *Oxyclænus*, where they are simply convex-concave, and not doubly so.

On the Trituberculate Type of Molar Tooth in the Mammalia. By E. D. Cope.

(Read before the American Philosophical Society, Dec. 7, 1883.)

It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular or tritubercular; that is, with two external and one internal tubercles.† Thus, of sixty-seven species of placental mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of the remaining sixty-five, all are triangular, excepting those of three species of Periptychus, and three of Conoryctes, which have a small supplementary lobe on each side of the median principal inner tubercle.

This fact is important as indicating the mode of development of the various types of superior molar teeth, on which we have not heretofore had clear light. In the first place, this type of molar exists to-day only in the insectivorous and carnivorous Marsupialia; in the Creodonta, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades.) In the Ungulates its persistence is to be found in the molars of the Coryphodontidæ of the Wasatch, and Dinocerata of the Bridger Eocenes. In later epochs it is occasionally seen only in the last superior molar.

It is also evident that the quadritubercular molar is derived from the tritubercular by the addition of a lobe of the inner part of a cingulum of the

* American Naturalist, 1883, p. 1056; Science, 1883, p. 275.

† See *American Naturalist*, April, 1883, p. 407,

posterior base of the crown. Transitional states are seen in some of the Periptychidæ (*Anisonchus*), and in the sectorials of the Procyonidæ.

The tritubercular or triangular superior molar is associated with a corresponding form of the anterior part of the inferior molar, This kind of inferior molar* I have called the tubercular sectorial, and is very variable as to the degree of development of the sectorial cutting edge. The anterior triangle is formed by the connection by angle or crest, of the median and anterior internal crests with the anterior external. Its primitive form is seen in Didelphys, Pelycodus, Pantolambda and the Amblypoda generally; in Centetes and Talpa; and in its sectorial form, in Stypolophus and Oxyæna, etc.

The mechanical action of such teeth is as follows: Of course, it results from the form of the superior molars that the spaces between them are wedge-shaped, the apex external, the base opening to the palate. The base of the triangular section of the anterior part of the inferior molar is interior, and the apex exterior, and when the jaws are closed, this triangular prism exactly fits the space between the superior molars. The lower heel of the inferior molar receives the impact of the crown of the superior molar. Thus the oblique edges of the inferior triangle shear on the edges of two adjacent superior molars. The anterior parts of the inferior molars, and the superior molars, form an alternate dental series as distinguished from the prevalent opposed dentition of most mammalia. In so far it resembles the reptilian dentition.

This primitive dentition has been modified in two directions; viz. to form the grinding and the sectorial dentitions. As already remarked, the superior molars gradually acquire a posterior internal lobe, which produces the quadrituberculate type. This lobe, by opposing the anterior internal lobe of the next posterior inferior molar, precludes the entrance of the anterior triangle of the latter between the two superior molars. Hence we find in the types which possess quadritubercular superior molars, that the anterior triangle of the inferior molar is not elevated, if present, as for instance in Rhinocerus. It is, however, more frequently atrophied, and disappears, forming the inferior quadritubercular molar so well known.

On the other hand, as I have pointed out,† the anterior internal cusp of the triangle of the inferior molar may be more developed anteroposteriorly, giving the antero-internal edge of the triangle much greater obliquity than the postero-internal. In correspondence with this modification, the superior triangular molar loses its equilateral character by the more anterior position of its internal angle, thus elongating the posterior internal side of the crown. The latter thus fits the corresponding form of the triangle of the inferior molar, forming with it the shear of the sectorial tooth.

* See Report G. M. Wheeler, D. Chief of Engineers on Explor. Surv. W. 100th Mer. Vol. IV, pt. ii; on the Creodonta.

† On the origin of the sectorial tooth of the Carnivora, *American Naturalist*, 1875.

In a former article, "On the Homologies of the Molar Teeth," etc., I traced the modifications of the superior and many of the inferior molars ot the ungulate mammals to a parent quadrituberculate type. In a subsequent essay* I traced the origin of the inferior sectorial to a primitive five-tubercled, or "tubercular sectorial" type. Farther than this I did not go, and made no attempt to derive the few cases of triangular superior molars then known, nor the type of the superior sectorial. The revelations of the Puerco fauna show, that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a "tubercular sectorial" type. Shall we look for the origin of the latter in a tritubercular tooth also, *i. e.* tubercular sectorial without heel; and will the crowns of the true molars of the primitive mammals alternate with, instead of oppose each other? This is a probable result of future discovery.

*Journal Academy Natural Sciences, Philadelphia, March, 1875.

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A. Agassiz
from
the author.

Paleontological Bulletin, No. 38.

SYNOPSIS
OF THE
SPECIES OF OREODONTIDÆ.

(Read before the American Philosophical Society, January 18, 1884.)

ON THE

STRUCTURE OF THE SKULL
IN THE
Elasmobranch genus Didymodus.

(Read before the American Philosophical Society, March 7, 1884.)

BY

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Synopsis of the Species of Oreodontidæ. By E. D. Cope.

(Read before the American Philosophical Society, January 18, 1884.)

The tribe Ruminantia first appears in the White River Miocene period in North American geological history. It is represented there by a number of genera, which pertain to several family types. The most aberrant ot these, the *Oreodontidæ,* includes the largest number of forms, generic and specific. The *Poëbrotheriidæ* certainly embraces but few species, while a third group of genera, represented by Leptomeryx, which are intermediate between the *Tragulina* and *Pecora,* and should be perhaps regarded as aberrant *Tragulidæ,* also includes a small number of species.

The *Oreodontidæ* constitute a family related to the *Anoplotheriidæ* of the later Eocene, but representing a more specialized condition of the structure of the molar teeth, in the full development of the selenodont type, which is rudimental in the *Anoplotheriidæ.* Their feet, on the other hand, are less specialized than in the latter family. As a family, the *Oreodontidæ* display very little tendency in their limbs to the specialized condition of the *Ruminantia,* but are more like those of the suilline groups, and, among recent families, of the *Hippopotamidæ.*

OREODONTIDÆ.

Dentition; superior incisors present; molars selenodont. Cervicals with the transverse processes perforated by the vertebrarterial canal. No alisphenoid canal. Ulna and radius, and tibia and fibula distinct. Metapodial bones four on each foot, with incomplete distal trochlear keels. Lunar bone not supported by magnum. Navicular and cuboid bones distinct.

The preceding synopsis of its characters should furnish a basis for the definite location of the *Oreodontidæ* in the system. Dr. Leidy called its species Ruminating hogs, and created a family for Oreodon and the allied genera, under the name of *Oreodontidæ.* This family is adopted by Prof. Gill who includes in it the *Agriochoeridæ* of Leidy, and places it in his division *Pecora,* which is more comprehensive than the *Pecora* of Prof. Flower, being nearly identical with the *Selenodonta* of Kowalevsky. More precise expression of its affinity to the existing families is not given, excepting to place it under a division "incertæ sedis."

As a selenodont type, this family is excluded from the *Artiodactyla omnivora,* and as having its metapodial bones distinct, it cannot be placed in any recent family excepting the *Tragulidæ.* From this family it is distinguished by the distinct ulna and radius. We then turn to the extinct families *Poëbrotheriidæ* and *Anoplotheriidæ.* The former agrees with the *Tragulidæ* excepting in its Cameloid cervical vertebræ, while the latter differs from the *Oreodontidæ* in the structure of the feet. The *Anoplotheriidæ* are didactyle in front, and tridactyle behind. The posterior foot has a well-developed second digit directed

more inwards than the others, which it is supposed supported a natatory web. In the Oreodontidæ all the feet are regularly tetradactyle.* The Anoplotheriidæ differ also in the presence of an additional cusp on the inner side of the superior molars, accompanied by an imperfect development of one or both pairs of the internal crescents. In *Anoplotherium* the internal crescents of the inferior molars are incomplete, and more or less represented by tubercles. In the *Oreodontidæ* there are two pairs of fully developed crescents, and no internal tubercles. The details of the structure express various affinities. The axis is intermediate between that of the suilline and ruminant *Artiodactyla;* the other cervicals are suilline, while the remaining vertebræ are ruminant. The scapula is ruminant, not suilline; while the humerus is like nothing but *Anoplotherium.* The radiocarpal articulation is intermediate between that of hogs and ruminants. The unciform supports the lunar bone. The sacrum is ruminant, the ilium suilline. The femur and tarsus are much like those of the peccary.

The genera of this family known to me are the following:

I. Orbit incomplete; last premolars in both jaws with two external crescents or Vs.

Premolars three. .... *Coloreodon.*

Premolars four .... *Agriochoerus.*

II. Orbit complete; premolars four, the fourth with one external crescent.

a. No facial vacuities.

Premaxillaries distinct; otic bullæ not inflated. .... *Oreodon.*

Premaxillaries distinct; otic bullæ inflated. .... *Eucrotaphus.*

Premaxillaries coössified; otic bullæ inflated. .... *Merycochoerus.*

aa. Facial vacuities present.

Premaxillaries coössified, dentigerous; vacuities prelachrymal only... *Merychyus.*

Incisors six above, persistent; vacuities prelachrymal and prefrontal; nasal bones much reduced.................... *Leptauchenia.*

Incisors very few, caducous; vacuities very large............ *Cyclopidius.*

III. Inferior premolars three.

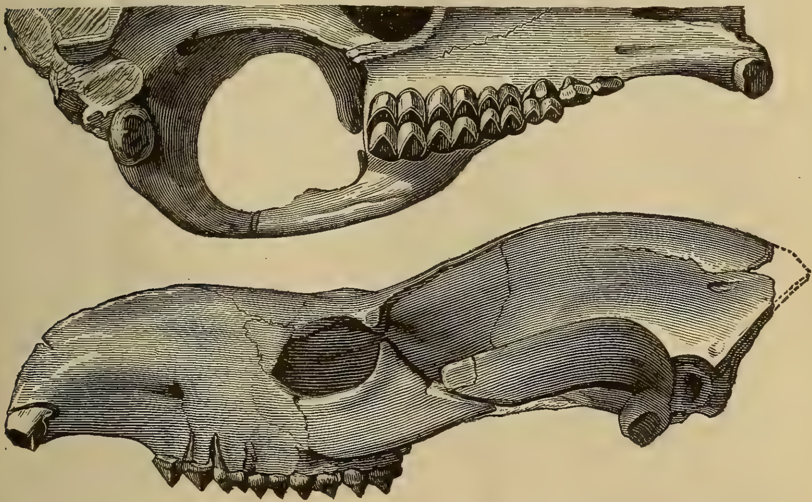
True inferior canine functional; inferior incisors one on each side. *Pithecistes.*

The number of species referred to these genera in the succeeding pages is as follows:

Oreodon	3
Eucrotaphus	3
Merycochœrus	7
Merychyus	6
Leptauchenia	3
Cyclopidius	2
Pithecistes	3
Agriochoerus	6
Coloreodon	2
	35

* I have observed this in the genera Oreodon, Eucrotaphus, Merycochœrus, and Merychyus.

The present paper is chiefly devoted to the proper distinction of these species and genera or cranial characters only. Figures of all will be given in my volume which embraces this subject, in the Report of the U. S. Geological Survey of the Territories.



Coloreodon ferox Cope, one-half natural size. Original; from Report U. S. Geolog. Survey Terrs., vol. iii, F. V. Hayden in charge.

OREODON Leidy.

Proceedings Academy Philadelphia, 1857, p. 238. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 29. Extinct Mammalia Dakota and Nebraska, 1869, p. 72. Report U. S. Geological Survey Terrs., 1873, I, p. 201. *Merycoidodon* Leidy, Proceeds. Acad. Philada., 1848, p. 47 (nomen nudum). *Cotylops* Leidy, Loc. cit., 1851, p. 239.

Premaxillary bones distinct from each other. Otic bullæ not inflated. No lachrymal vacuity of the face ; nasal bones normal. Premolars four in both jaws.

Dental formula I. $\frac{3}{3}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$; the series uninterrupted, Crowns of the molars robust, well distinguished from the roots. Grinding surface of the true molars simply selenodont, *i. e.*, with but two pairs of crescents. Superior premolars composed of a single external compressed cusp with crescentic section, and internal cingula or crescent. The fourth premolar with a well developed internal crescent ; the first three with rudimental internal crescents in the form of basal cingula. Superior canines distinct. Inferior premolars of two kinds ; the first canine-like in form and function ; the others consisting of a single external cutting edge rep-

resenting two crescents, of which the anterior has its posterior horn developed as an obliquely transverse crest directed inwards. Last true molar with a heel composed of two columns.

In the superior temporary dentition the last premolar has the form of the first permanent true molar. The third premolar has five lobes, *i. e.*, four crescents and an anterior odd one. The other temporary premolar resembles that of the permanent series. The last inferior temporary premolar has the three pairs of lobes usual in the *Artiodactyla*, and the two which precede it resemble the corresponding permanent teeth. Says Leidy : * "The permanent true molars successively protrude and occupy their functional position before any of the deciduous molars are shed. The displacement of the latter by their permanent successors appears to begin with the eruption of the last of these, which is followed by those in advance. The first permanent premolar of the upper jaw appears to have protruded after the deciduous teeth, and occupied a position with them in the functional series, but remains after these are shed."

The cranial characters which belong to *Oreodon* as a genus are the following : Orbit completed behind ; temporal fossæ separated by a sagittal crest. A lachrymal fossa, but no facial nor frontal vacuities. Premaxillary bones distinct from each other and from the maxillaries. Nasal bones well developed. Auditory bullæ not inflated.

The preceding dental and cranial characters have been pointed out by Leidy in his various palæontological works. On account of the absence of the necessary material he was unable to give the characters of the remaining parts of the skeleton. These are of course necessary to a correct estimate of the affinities of the genus, and I will endeavor to add such information as my material will permit. This consists of numerous more or less complete skeletons found in connection with the skulls by myself in Colorado in 1873.

Vertebræ. The *cervical* vertebræ are rather short, and the character of the articulation of the centra slightly opisthocoelous, and the articular faces are quite oblique. The axis is the longest vertebra ; the three last centra are subequal in length. In one of my series the seven cervicals are preserved. In all of these, excepting the seventh, the bases of the diapophysis are perforated by the vertebrarterial canal. In the sixth vertebra, the decurved parapophyses are especially robust. The axis and three succeeding centra display strong hypapophyses at their posterior extremities, which are carried forwards as strong median keels. The odontoid process is depressed so as to have a lenticular section ; it is not excavated above, but in my largest specimen the internal borders of the facets for the atlas are continued so as to enclose a short groove on each side at its base. In one smaller and immature specimen this is wanting. The vertebrarterial canal of the axis is enclosed as in the other cervicals. The canal for the second spinal nerve has a narrow roof, but there are no canals

* Ancient Fauna of Nebraska, p. 41.

for the succeeding pairs of nerves perforating the neural arches. The atlas is not very elongate. The base of the diapophysis has a perforating canal, which issues in a large inferior fossa. The vertebrarterial canal then perforates the diapophysis upwards anterior to the middle of the base, and then soon enters the neural canal just posterior to the superior margin of the cotylus of the occipital condyle.

The centra succeeding the cervicals increase gradually in length posteriorly. Those of the anterior part of the dorsal series are quite depressed, but the vertical diameter rapidly increases, so as to be equal to the transverse in some of the lumbars. A trace of the opisthocoelous articulation exists throughout the dorsals but is very little marked in the posterior centra. There are no hypapophyses on the dorsals, but on one of them, probably the third, the inferior and lateral faces are separated by a strong angle, which is strongest anteriorly, giving the articular face a subquadrate outline. The rib-bearing diapophyses are robust. On the posterior dorsals the capitular and tubercular surfaces are confluent, forming a narrow facet on the anterior face of the diapophysis, in a manner not seen in *Cervus elaphus* or *Sus scropha.* The centra of the lumbars, after lengthening, become shorter immediately in front of the sacrum. The vertical diameter of one or two posterior ones is less than that of the anterior ones. The greater number of the lumbars display a small compressed hypapophysis at their anterior extremity; but this is wanting on the posterior ones. The neural arches of the dorsal and lumbar vertebræ are nowhere perforated for the spinal nerves.

The lumbar prezygapophyses embrace the articular faces of the posterior ones, which have a section of one side (below), the end (external), and a half the other side (above), of a transverse ellipse. The superior recurved surface does not appear.

The sacrum consists of five vertebræ, with very depressed centra. The ilium is attached to the diapophysis of the first, and a small anterior portion of that of the second. That of the fourth is flat and free. The anterior zygapophysis of the first displays a slight degree of the superior incurvature general in *Artiodactyla.* The caudal vertebræ were numerous, forming a long tail. The proximal ones are moderately depressed, while more distal ones with wide diapophysis and complete neural arch, are subcylindric, and more elongate. The number of vertebræ preserved in the most complete of my specimens, is as follows:

	Cv.	D.	L.	S.	Cd.
O. culbertsoni ad..........	7	5	6	4	4
O. culbertsoni juv.........	5	8	6	2	1
O. gracilis..............	4	5	3	*	*
O. g. coloradoënsis.......	7	8	6	5	3

An anterior, perhaps second, *sternal segment* is flat and subquadrate in outline, with large hæmal articular face of the lateral margin anteriorly, and a small one posteriorly. No inferior carina.

The spine of the *scapula* rises abruptly from the neck as in Ruminantia, and the coracoid process is short and obtuse. The spine continues to the distal extremity, which is regularly convex.

The most perfect *innominata* in my collection are deficient in the symphysis. The form of the ilium is more that of a hog than of a ruminant. The peduncle is even stouter, and the superior border is abruptly expanded below the middle of the length of the bone. The superior and inferior borders are subparallel as in the hog, and not divergent as in the ruminants. The anterior edge is acute, and uninterrupted by an anterior inferior fossa or spine. The pubis is robust and transverse, and without prominent basal pectineal tuberosity. The incisura acetabuli invades the base of the pubis a little, but the ischium more extensively. The obturator foramen is quite large. The distal border of the ischium is obliquely truncated as in many other Artiodactyla, and more nearly resembles that of the peccary than any other recent form I have observed. The tuber proper is a convex edge, not thickened, and its superior edge is continued into a strong up-looking tuberosity. This region is not so robust as in most recent forms.

The *humerus* of *Oreodon* is readily distinguished from that of recent *Artiodactyla* by several peculiarities. The greater tuberosity is large, rising above the head ; and is incurved, terminating inwards in an acuminate apex. Its border at the base is thrown into an obtuse angle. The lesser tuberosity is small, and is well separated from the greater by a deep and wide bicipital groove. The deltoid ridge is distinct. The condylar extremity is more transversely extended than in any recent Artiodactyle, owing to the fact the posterior interior distal tuberosity is placed interior to the trochlea instead of partially behind it, and that there is, in addition, an internal epicondyle not seen in the recent suilline or ruminant members of the order. The intercondylar ridge is strong, and wider than in most recent ruminants ; in the suillines it has nothing like such a development. Another peculiarity is the flange-like free border of the external trochlea, which is especially recurved at its superior part.

The *radius* is distinct from the ulna throughout. The relation of the ulnar to the radiocarpal surface is posterior as well as exterior; the common suture of the two, making an angle of 45° with the long axis of the radiocarpal surface. The head is a transverse oval, with the inferior face forming a regular curve without notch. Its articular surface is divided into three portions in adaptation to the internal and external humeral trochleæ and the wide median ridge. The external face is beveled forwards above, to fit the flange-like projection of the external trochlea. The shaft of the radius is not very stout, and has a nearly equal transversely oval section to near the distal expansion. Here are wide grooves for the extensor tendons, one superior, the other obliquely exterior. The carpal articular facet has the general ungulate characters. The scaphoid facet is concave above, convex and condyloid below, and is only distinguished from the

lunar facet by a contraction of the anterior and posterior borders. There is no indication of distinguishing ridge between the lunar and cuneiform facets. The posterior border at their junction is prominent, enclosing a fossa with the scaphoid condyle, which does not, however, excavate the intervening surface. The scaphoid condylo is not divided by a ridge.

The *ulna* gradually contracts distally from a robust olecranon. The shaft beyond the humeral cotylus has an oval section, with its long axis forming an angle of 45° to the perpendicular. The olecranon is short and compressed, its posterior border rising nearly as high as the coronoid process. The edges of the humeral cotylus are not flared beyond the shaft.

In the *carpus* the unciform nearly reaches the scaphoid, which is supported by the magnum and trapezium.

The great trochanter of the *femur* is not produced beyond the line of the head, and is well recurved, enclosing a large fossa. The little trochanter is large. The *fossa ligamenti teris* is submedian, subround and large. Distally, the patellar trochlear groove is quite elevated ; its lateral crests are of equal prominence, and nearly equal superior prolongation. The patellar groove is continued some distance above the crests, but there is no fossa in this region as in the hog. The popliteal fossa is well marked, and the condyloid articular surfaces are not entirely cut off from the rotular. The external linea aspera terminates first in a rugose muscular insertion, and then in a shallow fossa a short distance above the condyle. There is no crest nor deep fossa. This element is more like the corresponding one in *Dicotyles torquatus* than in any other mammal. The patella is a short wide bone, with a large anteroposterior diameter. One extremity is acute, the opposite one truncate.

The head of the *tibia* is also like that of *Dicotyles*. The spine is divided as usual, and not much elevated ; the crest is prominent, but is wide and truncate above at the head. It is not excavated as in *Sus*. The external tendinous notch is well marked. The external margin of the shaft does not display any sutural surface for the fibula. The surface of attachment of an external malleolus is distinct. The internal malleolar process is narrow and is produced well downwards. The anterior intertrochlear angle is prominent ; the posterior only convex. The trochleæ are deep, the outer being both the wider and the deeper.

The *astragalus* presents well marked characters. The distal extremity displays the two usual parallel trochleæ, which are separated by a pronounced angle. The cuboid trochlea slopes somewhat backwards, while the navicular is strongly concave. The tibial trochleæ are unequal, the internal being smaller than the external. It is separated from the latter by a constriction which is well rounded and not angulate as in the hog. The external side of the astragalus displays a wide malleolar band, a wide posterior and narrow anterior calcaneal facets, and an undivided concavity intervening between the latter. On the inner side, the malleolar face

descends to below the middle, as in *Hypertragulus,* and there is no vertical nor horizontal distal crest. The inferior calcaneal facet is undivided and not grooved, and does not extend over the internal border of the inferior side of the bone. It exhibits an acute border on the external side. The calcaneum is rather elongate, and the free portion is compressed and with obtuse margins above and below. The transverse astragalar process is not large and is not produced beyond its facet. The ascending plate is well developed and has a superior, uninterrupted convex facet for the fibula, with a narrow facet on its inner side. The inner distal astragalar facet extends the entire length of the cuboid facet. There is a longitudinal ridge on the external side of the distal end of the calcaneum.

The *navicular* and *cuboid* bones are distinct from each other and from the ectocuneiform. The astragalar ligamentous fossa is in the naviculo-cuboid suture. The inferior proximal angle of the cuboid is produced posteriorly, and the peroneal process well forwards. The ectocuneiform is distinct, and much wider than long. The mesocuneiform is exterio-posterior in position, and the transverse diameters are small. It is produced distally, overlapping the head of the second metatarsus. Entocuneiform wanting. The metapodial bones are entirely distinct. The lateral metatarsals are well developed. The second articulates with both the ecto- and mesocuneiform bones, by a proximal extremity which is laterally compressed. The third and fourth are subequal in width, and articulate exclusively with the ectocuneiform and cuboid respectively. The fifth metatarsus is compressed proximally, and the external part of its extremity articulates with a lateral fossa of the cuboid. The distal articular extremities of the metapodials are separated from the anterior face of their shafts by a transverse groove ; and they have a well marked articular fossa on each side. The trochlear tongue only exists on the posterior face, where it is prominent and compressed. It disappears on the middle of the distal end, and is wanting on the anterior face. The phalanges are depressed proximally, the penultimate ones distally also. The ungues are rather depressed and have convex external borders. There is a pair of sesamoid bones below the distal articular extremity of the metatarsals.

History. The dental and cranial characters of this genus were fully described by Dr. Leidy in 1852, as already cited. In the Extinct Mammalia of Dakota and Nebraska, published in 1869, Dr. Leidy added the following points in the osteology of the skeleton of the *Oreodontidæ* (p. 72) : "What are supposed to be the bones of the forearm and leg are discrete, as in the hog, and the bones of the feet correspond in number with those of this animal." In 1873* Prof. Marsh confirmed these statements so far as regards the metacarpal bones, and added that "the navicular and cuboid bones were loosely coössified or separate." The structure of the vertebræ, and of the greater part of the scapular and pelvic arches,

* Amer. Journn. Sci. Arts, p. 409.

with the carpus, tarsus and feet, with the exceptions above noted, are now described for the first time.

This genus appears first in time in the known history of the family, and presents us with its primitive or least specialized characters, or those nearest the average condition of the ordinary primitive ungulate.

Species. The species of this genus are difficult to discriminate from the evidence of crania alone, and their true number will remain uncertain until we can study entire skeletons. My material enables me to make some progress in this direction. After the removal of the forms with inflated bullæ to the genus *Eucrotaphus,* there remain the two species originally referred to Oreodon by Leidy, the *O. culbertsoni* and the *O. gracilis.* To these Leidy subsequently added two others, the *O. affinis,* which is intermediate in size between the two named, and the *O. hybridus,* of larger size than either. As the condition of the otic bullæ in the last is unknown, its generic reference is not certain. All these forms are from the White River epoch of Dakota, Nebraska and Wyoming.

My material is largely from the White River beds of Colorado. I find from this region the true *O. gracilis* and the *O. culbertsoni,* abundantly represented. Besides these there is a form intermediate between the *O. gracilis* and the *O. affinis,* which is nearer the former than the latter. Of *O. gracilis* there are two skulls complete; of the form next larger, which I call *O. gracilis coloradoënsis,* two complete crania (one with skeleton), and a face with teeth. Of a form between the *O. affinis* and the *O. culbertsoni,* there are four skulls complete (two with skeletons); and of *O. culbertsoni* proper, numerous parts of skulls with teeth, but none complete. No other regions which I have explored have produced these species; not even the Ticholeptus beds, where they might have been reasonably expected to occur.

The distinction of the previously known species will remain as Leidy has left it, with certain reservations in the matter of dimensions; while I add two sub-species.

Nasal bones obtuse posteriorly; frontals little produced on either side of them; true molar teeth not exceeding M. .035 in length; canine and premolars .030; width of front .046. *O. gracilis.*

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .037 in length; canine and premolars .039; width of front at middle of orbits .046. .... *O. coloradoënsis.*

Nasal bones obtuse posteriorly, frontals little produced on either side of them; true molar teeth not exceeding .038; front at orbits .057 in width. .... *O. affinis.*

Nasal bones acute posteriorly; frontal produced to an acute apex on each side of them; molar teeth .040; front, .056. *O. periculorum.*

Nasals and frontals as last; molar teeth .047; front, .050+.. *O. culbertsoni.*

From this table it may be seen that the passage from the small *O. gracilis* to the large *O. culbertsoni* is accomplished by a series of intermediate steps. That these extreme forms belong to one species cannot be admitted without evidence of more complete transition than we yet possess. As above remarked, groups of specimens represent each form and adhere to the definitions given with considerable fidelity. The largest of the specimens I refer to, the form *O. periculorum,* however, reaches .042 in the length of the true molar teeth, and the smallest of the *O. culbertsoni* measures .046. These I must consider as sub-species only. As regards the three remaining forms the length of the true molar series shows a complete gradation. The size of the cranium, as indicated by the interorbital width, is in the *O. affinis* as large as that of the *O. culbertsoni* according to Leidy, and the combination of characters presented by this form, would seem to entitle it to specific rank as suggested by Leidy. On the other hand the form *coloradoënsis* agrees in interorbital width with the small *O. gracilis,* differing from it in the greater length of the muzzle and of the cranium. But here, while the proportions of the premolar teeth distinguish the forms well, the length of the brain-case does not coincide exactly with the other measurements. The measurements of four skulls are as follows: *O. gracilis* No. 1, length of skull M. 114.5; No. 2, .130. *O. coloradonësis* No. 1, .129; No. 2, .135.

Oreodon gracilis Leidy.

Proceedings Academy Philada., 1851, 239; 1853, 392; 1854, 157; 1857, 89; Owen's Report Geolog. Survey, 1852, 550, Pl. XI, figs. 2–3; Pl. XIII, figs. 5–6. Ancient Fauna Nebraska 1853, p. 53, Pl. V, figs. 3–4; VI, figs. 1–7. Extinct Fauna Dakota and Nebraska, 1869, 94, Pl. VI, figs. 2–3.

Abundant in the White River beds of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are distinguished as follows:

Length of superior premolar series, M. .023................ *O. g. gracilis*
Length of superior premolar series, M. .029 .... *O. g. coloradoënsis.*

Oreodon gracilis gracilis Leidy.

Dakota, Nebraska and Colorado.

Oreodon gracilis coloradoënsis Cope.

Colorado.

Oreodon affinis Leidy.

Extinct Mammalia Dakota and Nebraska, p. 105; Pl. IX, fig. 3.

Probably from the White River beds of Nebraska.

Oreodon culbertsoni Leidy.

Owen's Report Geological Survey, 1852, 548, Pl. X, figs. 4–6; XIII, figs. 3–4; Ancient Fauna Nebraska, Smithsonian Contrib. to Knowledge, 1853, 45; Pl. II, III, IV, figs. 1–5, V, figs. 1–2, VI, figs. 8–11; Proceeds.

Academy Philada., 1853, 392; 1854, 35, 157; 1857, 89; Bronn Lethæa Geognostica, 1856, 930. Extinct Fauna Dakota and Nebraska, 1869, p. 86; Pl. VI, fig. 1; VII fig. 2; IX, figs. 1–2. *Merycoidodon culbertsoni* Leidy, Proceeds. Acad. Phila., 1848, 47, Pl. II; 1850, 121; 1851, 239. *Oreodon priscum* Leidy, Proceed. Phila., Academy 1851, 238; *Cotylops speciosa* Leidy, Ibidem 239; *Oreodon robustum* Leidy, Ibidem 276.

The White River epoch of Dakota, Nebraska, Colorado and Wyoming.

The two sub-species are defined as follows:

Length of superior true molar series from M. .040 to .042. .... *O. c. periculorum.*

Length of superior true molar series from .046 to .050.... *O. c. culbertsoni.*

Oreodon culbertsoni periculorum Cope.

This smaller race or sub-species has as yet only been found in the White River beds of Colorado and Wyoming. I do not detect any differences between it and the Nebraska form other than those of size. The largest measurement of the *O. c. culbertsoni* given in the above table is derived from Leidy; my largest specimen gives .047 as the length of the true molar series.

Oreodon culbertsoni culbertsoni Leidy.

Very abundant in the White River formation of Dakota, Nebraska, Colorado and Wyoming.

EUCROTAPHUS Leidy.

Proceedings Academy Philada., 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contrib. to Knowledge, 1853, p. 56. *Eporeodon* Marsh, Amer. Journ. Sci. Arts, Vol. ix, 1875, p. 249.

Premaxillary bones distinct from each other. Otic bulla swollen. No prelachrymal or nasal vacuities.

This genus presents us with the first step in the series of modifications which the primitive form underwent with the advance of geological time. It appeared contemporaneously with the earliest representatives of the family, *i. e.*, in the White River epoch, but in small numbers. In the succeeding or John Day epoch the genus Oreodon had disappeared, and the present form had multiplied enormously in individuals, if not in species. Subsequent to that epoch it is unknown.

The greater number of the Oreodont remains found in Oregon belong to this genus. The *Eucrotaphus jacksoni* bore the same relation to the Oregon John Day fauna, as the *Oreodon culbertsoni* did to that of the White River epoch.

The species of Eucrotaphus are distinguished as follows:

I. Palatonareal border well posterior to posterior edge of maxillary bones.

a. Infraorbital foramen above front of P-m. iii.

Skull depressed, muzzle short; paroccipital process behind bulla and not separated from it by grooves; bulla grooved to apex for styloid ligament, etc.; zygoma more robust. *E. trigonocephalus.*

II. Palatonareal border in line with posterior edges of maxillary bones.

aa. Infraorbital foramen above posterior part of third premolar.

Paroccipital process behind otic bulla, the internal border of its base opposite that of the bulla.......................*E. jacksoni.*

Paroccipital process external to the middle of the otic bulla; generally larger.......................................*E. major.*

The name here employed for this genus is the one first given with a definition. The typical species, *E. jacksoni*, was widely distributed, and appears under several varietal forms and sizes, some of which have received names. Subsequently to the original description, Dr. Leidy added to the genus a second species, which probably belongs to the genus Agriochœrus. On this account Leidy inclined at one time to combine the two genera, but afterwards abandoned the idea.

Eucrotaphus trigonocephalus, sp. nov.

This distinct form is only known to me from a single skull of an old animal. In the character of its otic bulla it has resemblance to the species of Agriochœrus, while the maxillary part of the skull has the posterior position of a true Oreodon.

The muzzle is rather depressed, and the premaxillary alveolar border is almost transverse. The position of the canine alveolus is swollen laterally, and between it and the infraorbital foramen the side of the face is slightly concave. The expansion leading to the malar bone commences as the posterior slope of the concavity mentioned, and spreads laterally, without interruption, beginning to project beyond the superior alveolar border at the fourth superior premolar. In the *E. jacksoni* this is not apparent anterior to the first true molar. The top of the muzzle and the front are wider than in that species, and are gently concave in the transverse direction. The anterior temporal ridges are well defined, and concave in outline, uniting early to form a prominent sagittal crest. The malar bone is a little concave below the orbit. The malar process of the maxillary projects downwards in an obtuse angle, opposite the penultimate superior molar. In *E. jacksoni* the malar is convex, and the tuberosity is opposite the last molar. The squamosal process is deeper than in the *E. jacksoni*, and sends a more robust apex into the malar bone, the apex not extending in front of the posterior border of the orbit. The supraoccipital crests are well developed, and project beyond the vertical plane of the condyles; they continue into well marked posttemporal crests, as in the other species of the genus, as well as send an obtuse ridge downwards on each side towards the foramen magnum. The median supraoccipital plane disappears downwards in a wedge-shaped apex, which causes the transverse section

above the foramen magnum to be obtuse angulate instead of broadly flattened as in *E. jacksoni.* The mastoid crests are roughened and are vertical, but do not continue directly into the paroccipital processes, but are separated from them by a deep excavation of the external margin, due to the internal position of the base of the process.

The long diameter of the base of the paroccipital process runs outwards and backwards, and it is attached to the bulla at the middle of the posterior extremity without any intervening grooves such as are seen in the other species of the genus. The bullæ are ovoidal in anteroposterior section, the regularity interrupted, however, by the presence of a ridge on the external side directed posteriorly, enclosing a groove which is continuous with the stylohyoid fossa. The ridge continues into the inferior crest of the tympanic bone. The sphenoid bone is regularly convex in transverse section, while the basioccipital is concave on each side with a narrow median keel, which commences opposite the anterior edge of the paroccipital processes. The basicranial axis is not quite in line with the basifacial, but does not present such an angle with it as is seen in the species of Merycochœrus, where the skull is known to me. In this respect it agrees with the other species of the genus. The postglenoid processes are less prominent than in *E. jacksoni,* but have a base more widely extended outwards. The external border is very oblique, since the apex is narrowed. The glenoid region is more extended, both transversely and anteroposteriorly than in the *E. jacksoni.* The anterior border is continued as an alisphenoid angle which becomes prominent, and overhangs the foramen rotundum. The descending alisphenoid ridge commences within the anterior border of the foramen ovale. The pterygoid angle is anterior to the middle of the palatosphenoid wall of the nareal foramen, and in front of it the edge of the processus pyramidalis is marked by a shallow fossa or mark of insertion of the internal pterygoid muscle. The nareopalatal border is as far posterior to the line connecting the posterior edges of the maxillaries as the width of the second molar tooth. The palate is everywhere nearly flat. The malar bones spread well away from the maxillaries on each side, the anterior border of the zygomatic foramen being a segment of a circle. The squamosal part of the zygoma is more widely expanded than the malar part. In *E. jacksoni* the shape of the zygomatic foramen is quite different. Its anterior outline is interrupted by the projection of the maxillary bone posteriorly, which gives its anterior outline a bilobate form. It is longer than wide in that species, and wider than long in the *E. trigonocephalus.*

The infraorbital foramen is small. There are two lachrymal foramina ; one larger, within the preorbital border, the other smaller, below the tuberosity on the rim of the orbit. The frontal foramina are separated by a space equal to one-fourth the entire frontal width. The supraorbital notches are wanting. The preorbital fossæ are well marked, are distinctly defined above, and extend as far as the anterior border of the lachrymal bone. The orbit is round, and looks upwards as well as outwards and

forwards, on account of the prominence of the zygomatic arch. There are two postparietal foramina, one below and behind, the other on the parieto-squamosal suture. The mastoid foramen is not small. The incisive foramina are large, are longer than wide, and are separated by a rather wide isthmus. The palatine foramina are opposite the third premolars. There is a foramen immediately below the postfrontal process. The optic foramen issues posterior to the line of the posterior border of the orbit, and in front of the anteroinferior angle of the alisphenoid. The foramen rotundum is large and round, and is immediately below and within the ridge above mentioned, and is not overhung by a transverse ridge of the same, as in the species of Meryeochœrus known to me. The f. rotundum doubtless includes the f. sphenoörbitale. The f. ovale is smaller and is separated by a considerable interval from the f. lacerum. The latter is subtriangular in form and is rather small, since the base of the otic bulla is in close sutural contact with the sphenoid and basioccipital for a considerable distance. The f. jugulare is subtriangular in outline and is smaller than the f. rotundum. It is entirely distinct from the f. condyloideum, which is the size of the f. ovale. No f. supraglenoideum. In comparing these foramina with those of the *E. jacksoni*, a general resemblance is to be seen. The frontal foramina in that species are *generally* closer together than in *E. trigonocephalus*, and the palatine foramen is *generally* opposite the fourth premolar instead of the third. The foramen magnum is slightly notched on its superior border in both.

The posterior outline of the nasal bones is truncate; it is more or less acuminate in all the specimens of *E. jacksoni* and *E. major* accessible to me. The prolongation of the frontal on either side of the nasals is also short and truncate in this species, and narrow and acuminate in the *E. jacksoni* and *E. major*. The lachrymal is deeper than long; in the species last named it is of variable size and form, but is usually as long as deep. There is no distinct ridge along the parieto-squamosal suture. The alisphenoid has a considerable contact with the pariëtal. The palatomaxillary suture is irregularly convex backwards on each side of the median line. It crosses the palate as in the *E. jacksoni*, at the front of the second maxillary tooth.

The teeth are much worn, and the first and last true molars with several of the premolars have been lost, indicating the age of the animal. The incisors are small and have round roots. The canines are large and of the usual form. The space between them and the first premolar is short. The fourth premolar is small. The second true molar is wider than long, and has no internal cingulum except between the lobes, and has a trace of anterior cingulum.

Measurements.	M.
Axial length from occipital condyles to premaxillary border	.187
Axial length from occipital condyles to postglenoid process	.031

Measurements.	M.
Axial length from occipital condyle to postfrontal process	.076
Axial length from occipital condyle to palatonareal border	.079
Axial length from occipital condyle to end of last molar	.091
Diameters of orbit { vertical	.031
Diameters of orbit { horizontal	.027
Depth malar bone at middle of orbit	.016
" zygomatic process posteriorly to glenoid face	.028
" skull (right angles to profile) at glenoid face	.045
" " " " orbit	.046
" " " " P-m. i	.030
Elevation of occiput from foramen magnum	.044
Width top of muzzle at preorbital fossæ	.040
" at middle of supraorbital border	.059
" " postfrontal process	.075
" " malar below orbit	.110
" " zygomatic process of squamosal	.145
" of occiput at condyles	.066
" " occipital condyles	.039
" " palate at palatonareal foramen	.028
" " " at M. ii	.032
" " " " canines	.030
Length of superior dental series with canines	.088
" " premolar series	.047
" " true molar series	.036
Diameters canine at base { anteroposterior	.009
Diameters canine at base { transverse	.010
Diameters P-m. iv. { anteroposterior	.009
Diameters P-m. iv. { transverse	.013
Diameters M. ii. { anteroposterior	.014
Diameters M. ii. { transverse	.018

The typical specimen of this species was found by Charles H. Sternberg on the North Fork of the John Day river. The horizon is probably somewhat different from that of the true John Day epoch.

Eucrotaphus jacksoni Leidy.

Proceedings Academy Philadelphia, 1850, p. 92. Ancient Fauna of Nebraska, Smithsonian Contributions to Knowledge, 1852, p. 56, Plate VII, figs. 4–6. *Oreodon bullatus* Leidy, Extinct Mamm., Dakota and Nebraska, 1869, p. 106. Report U. S. Geol. Survey, Terrs. 1873, I, p. 318. *Oreodon occidentalis* Marsh, Amer. Journal Sci. Arts, 1873 (May), p. 409. *Eporeodon occidentalis* Marsh, Loc. cit., 1875, p. 250. *Eucrotaphus occidentalis* Cope, Bulletin U. S. Geol. Survey Terrs., V, p. 59.

Comparison of numbers of crania from the White river and John Day

formations fails to reveal any characters distinguishing them as more than one species. In fact the variation in various respects is greater among the individuals of the John Day epoch, than between those of the two epochs. This was by far the most abundant mammal of the John Day epoch while it appears to have been rare during that of the White River.

Specimens differ in the size of the preorbital fossa irrespective of other differences. In some specimens it is wide and profound, including the lachrymal bone; in others it is less extensive and is shallow, involving but part of the lachrymal. It is never wanting or obscure. For estimation of other characters, I select ten crania, nine from Oregon and one from Dakota, as expressing the greatest range of variation. Of these, three display a peculiarity in the form of the otic bulla. Instead of being contracted backwards in front, it is protuberant and full at its inferior anterior part. Five other crania, agreeing with these three in other respects, possess the normal form of bulla. In one cranium, which is rather more robust than the others, the infraorbital foramen is a little posterior to its usual position, being above the anterior part of the fourth premolar. This tooth is also distinctly smaller than in other specimens of otherwise similar dimensions. The majority of specimens range nearly alike in dimensions, but there are forms distinctly larger and smaller, which may represent distinct species. This question can be better decided when the skeletons are known. I give three sub-species which are defined as follows:

Length of cranium M. .197; of molar series M. .086; long diameter of base of paroccipital process transverse; its posterior base flat.. *E. j. jacksoni.*

Length of cranium M. .219; of molar series M. .091; paroccipital process as above....................................*E. j. pacificus.*

Length of cranium, M. .235; of molar series, M. .099; paroccipital process strongly compressed, its posterior base angulate on the middle line...........................*E. j. leptacanthus.*

The above measurements of length are made from the occipital condyles to the premaxillary border inclusive.

The three forms may represent good species. The *E. j. jacksoni* is of the size of the *Oreodon culbertsoni;* the *E. j. leptacanthus* is larger than the *E. major,* while the *E. j. pacificus* is intermediate between the two.

Eucrotaphus jacksoni jacksoni Leidy.

The typical specimen of the *Oreodon bullatus* Leidy agrees so nearly with the original type of *Eucrotaphus jacksoni,* that I cannot doubt their pertinence to the same species. There are two specimens in the collection of the Philadelphia Academy, besides the last named, and at least one in the museum at Princeton. A specimen from the John Day, Oregon, cannot be distinguished from these. It agrees with Marsh's measurements and description of his *Oreodon occidentalis,* and no doubt represents it. Its

identity with his *O. bullatus* has already been surmised by Leidy (Report U. S. Geol. Survey Terrs., I, p. 318).

Eucrotaphus jacksoni pacificus Cope.

This form is materially larger than the last named, equaling in dimensions and resembling in general form the *Eucrotaphus major* Leidy, of the White River beds. It is no doubt the form which has been identified under that name by Leidy in his report on John Day Fossils in the Report of the U. S. Geological Survey of the Territories, Vol. I. It is different from that animal in the form and position of the paroccipital process, as already pointed out. I have eight crania disengaged from the matrix which agree in dimensions and other characters assigned to this sub-species. In one of them the paroccipital process presents an approach to the form of that of the *E. j. leptacanthus.* A specimen from the White Buttes of Central Dakota agrees with those from Oregon in all the essential characters, and is the second one of the sub-species I have seen which is not Oregonian. I have many crania of this sub-species not yet entirely cleared of matrix.

From John Day river and Crooked river, Oregon ; C. H. Sternberg and J. L. Wortman ; White river of Nebraska, Mus. Princeton.

Eucrotaphus jacksoni leptacanthus Cope.

This is the largest form of the genus, exceeding the typical *E. major* in the length of the skull by 23 mm. It is thus far represented in my collection by two very perfect crania. There is considerable reason for anticipating that this form will turn out to be a valid species. Besides the peculiar form of the paroccipital processes, the typical specimen presents the following characters :

The frontal region is flatter than in the two other sub-species, and is concave on the median line in transverse section. This concavity is probably partly abnormal. The profile of the sagittal crest instead of presenting a gently convex outline, is concave, rising posteriorly. The lateral occipital crests instead of being angulate are truncate behind, and the inferior angle projects much beyond the vertical line of the occipital condyles. As this part is broken off in most of my specimens of the *E. j. pacificus,* I cannot decide as to its value. The inferior carina of the tympanic bone extends forwards to contact with the internal extremity of the postglenoid process. It does the same in the Oregon specimen of *E. j. jacksoni,* and in the Dakota specimen of the *E. j. pacificus.* In two of the latter, from Oregon, where the part is cleaned, the keel does not extend so far forwards or inwards.

The typical specimen is from the John Day beds of John Day river, Oregon, and was found by Jacob L. Wortman.

Eucrotaphus major Leidy.

Oreodon major Leidy, Ancient Fauna of Nebraska, 1853, p. 55, Pl. IV, fig. 6. Proceedings Academy Philadelphia, 1853, 398 ; 1856, 164 ; 1857, 89.

Extinct Mammalia, Dakota and Nebraska, 1869, p. 99, Pl. VII, fig. 1; VIII. *Eporeodon major* Marsh, Am. Journ. Sci. Arts, 1875, p. 250.

I find this species to differ in the external position of the paroccipital process, as related to the otic bulla, from the *E. jacksoni.* I might add that it differs in dimensions from all excepting the *E. jacksoni pacificus.* In the *E. jacksoni* the base of the paroccipital process is in the same line as the interior base of the otic bulla. In the Oregon form of the *E. major* the base of the paroccipital process is much flattened, so as to be transverse, and its internal border is on the external side of the extremity of the large swollen bulla. This species differs also from the *E. jacksoni* in the median vertical carina of the occipital bone above the foramen magnum, a region which is in the *E. jacksoni* broadly flattened. Besides these points I do not notice any divergence from the *E. jacksoni,* with which it agrees in the various characters in which the latter differs from the *E. trigonocephalus.*

The Nebraska and Oregon forms do not agree in all respects. Thus, while the dimensions of the dental series are the same in both, the frontal region is more elongate in the Oregon animal, giving greater length to the skull. The third superior premolar has a somewhat different form in the two. They may then be characterized as follows:

Dental series M. .125; skull .224; third superior premolar, subtriangular.. *E. m. major.*
Dental series M. .125; skull .240; third superior premolar subquadrate.. *E. m. longifrons.*

Eucrotaphus major major Leidy.

Known only as yet from the White River epoch of Nebraska and Dakota.

Eucrotaphus major longifrons Cope.

Known from a single skull from the North Fork of the John Day river, Oregon, found by Charles H. Sternberg. It may be observed here that the Oreodontidæ of this locality are mostly distinct from the species of the John Day river proper.

MERYCOCHŒRUS Leidy.

Report U. S. Geol. Survey Terrs., I, 1873, p. 202. Bettany, Quart. Journ. Geol. Soc. London, 1876, p. 262; Cope, American Naturalist, 1884, p. 281. Leidy, Extinct Mammalia of Dakota and Nebraska, 1869, p. 110 (nomen nudum). Proceedings Academy Philadelphia, 1858, p. 24 (nomen nudum).

As indicated in the analytical table at the head of this article, I can only distinguish this genus from *Eucrotaphus* by the confluence of the premaxillary bones. The position of the external infraorbital foramen cannot be regarded as furnishing generic characters, especially as it displays considerable variation and gradation. Some of the species are in this respect quite identical with species of Merychyus (*M. superbus*), while others

possess the widely different position ascribed to this genus by Leidy. Few if any of the characters given by Mr. Bettany as those of the genus, can be regarded as other than characters common to several of its species. Perhaps the most important of these is the angle formed by the basifacial with the basicranial axis, by which the face is presented as much forwards as upwards. The species present considerable variety in form. The genus embraces the largest species of the family, such as *M. macrostegus*, *M. superbus*, etc. The characters of the species are as follows :

I. Foramen infraorbitale above middle of fourth superior premolar ; posterior part of zygoma expanded ; palate moderately produced posteriorly.

Squamosal part of zygoma less expanded anteriorly and with rounded border ; head elongated ; premaxillary bone not produced ; otic bulla larger, compressed, extending anterior to postglenoid process ; size large .... *M. superbus*.

Head shortened occipitally, so that a line drawn through post-glenoid and paroccipital processes makes 90° with the middle line ; malar bone openly grooved below orbit ; angle of mandible obliquely truncate. .... *M. leidyi*.

Squamosal part of zygoma most expanded in front, and elevated behind, so that the cranium is as wide as from the paroccipital process to the canine tooth ; its posterior angle rising to a level with the sagittal crest ; its inferior edge spread outwards ; its superior edge truncated ; occiput not shortened ; malar flat below orbit ; postglenoid process marking front of bulla.. *M. chelydra*.

II. Foramen infraorbitale above the first true molar. Palate greatly produced posteriorly.

Squamosal part of zygoma much expanded, and with truncate edge ; malar bone robust, prominent ; skull, width equal length from condyles to first premolar ; maxillary produced anteriorly ; frontal plane, transverse diamond-shaped ; bulla small, conical, posterior to anterior edge of postglenoid process.. .*M. macrostegus*.

Squamosal part of zygoma little expanded upwards or laterally, edge rounded ; malar bone flat ; bulla large, extending in front of postglenoid process ; front longitudinally diamond-shaped, decurved at orbit.................... *M. montanus*.

III. Foramen infraorbitale above anterior border of second true molar.

Zygoma originating above second molar ; large ; incisors small (fide Leidy). .... *M. rusticus*.

Zygoma originating above third true molar ; larger ; incisors large (fide Leidy). . ... *M. proprius*.

Of the above seven species, four are represented in my collection, some of them by a large amount of material. The latter are from the John

Day and Ticholeptus Miocene horizons. The *M. rusticus* of Leidy is only known to me from the descriptions of that author. It is from the Sweetwater river, Wyoming, from a bed of probably Ticholeptus age. The *M. proprius* Leidy, also unknown to me by autopsy, is from the head of the Niobrara river, Nebraska, from a bed said by Hayden to be intermediate between the Oreodon or White River and Procamelus, or Loup Fork horizons, and therefore probably of Ticholeptus age also. The *M. leidyi* I only know from the description of Mr. Bettany. It is from the John Day beds. Mr. Bettany also describes an *M. temporalis*, which I cannot distinguish from the *M. superbus* Leidy.

Merycochœrus superbus Leidy.

Oreodon superbus Leidy, Proceedings Academy Philadelphia, 1870, p. 109. Extinct Mam. fauna, Dakota and Nebraska, 1869, p. 211; Plate I, fig. 1; II, fig. 16; VII, figs. 7–11. *M. temporalis* Bettany, Quar. Journ. Geol. Soc., London, 1876, xxii, p. 269; Pl. XVII.

Of this fine species I have nine crania extracted from the matrix, and a good many not yet cleaned. As the specimen described by Leidy is in a very imperfect condition, the characters of the species, and even its generic position, have remained hitherto very obscure.

As compared with the allied species, the *M. superbus* is slightly exceeded in size by the *M. macrostegus* and *M. montanus*. Its posterior zygomatic expansion is less pronounced than in the *M. macrostegus* and *M. chelydra*, and its border is rounded, even when, as is sometimes the case, it is greatly thickened. In the first and last named of the above species, its border is separated by a distinct angle from both the internal and external faces, forming thus a distinct truncate face which looks upwards. The otic bulla is larger than in the two species mentioned, and extends anterior to the postglenoid process. The nareal fissure extends well down towards the alveolar border of the premaxillaries, which are therefore more extensively separated than Leidy represents to be the case in the *M. rusticus*. The external face of the malar bone below the orbits is flat. The anterior extremity of the zygomatic process is not so prominent as in *M. chelydra*, and is rounded instead of being flared out below, as in that species. The greatest width of the skull is at the glenoid surfaces, and not anterior to them, as in *M. chelydra*. In only one of seven crania, where the parts are preserved, does the posterior squamosal angle rise as high as the sagittal crest.

I cannot detect any difference between the specimen described by Mr. Bettany as the type of his *M. temporalis*, and those of the *M. superbus* in my possession. The shallowness of the preorbital fossa described by Mr. Bettany is repeated in one of my crania, and its depth is very variable in the others. As regards the *M. leidyi* of Bettany, I have none exactly like it, although the type specimen does not differ much from the *M. superbus*, to judge from the figure and description given in the Quarterly Journal of the Geological Society, 1876, p. 270. The two distinctive

characters, which appear most tangible among those mentioned by Mr. Bettany, the shortness of the occipital region, as measured by the angle made by a line drawn through the postglenoid and paroccipital processes, with the middle line, and second, the grooved character of the sub-orbital part of the malar bone, are not found in any of my specimens of *M. superbus.* The anterior extremity of the squamosal process of the zygoma is protuberant in one of them, as in the *M. leidyi.* Another character is suggested by Mr. Bettany's figure, but is not mentioned in the text. The angular border of the mandibular ramus extends obliquely forwards instead of being prominently convex as in the best preserved entire mandible of the *M. superbus* in my possession. Nevertheless in another specimen, where a good deal of the posterior border is preserved, the outline is nearly as oblique as in the *M. leidyi.* The species, however, is distinct so far as now known.

John Day epoch, Oregon, C. H. Sternberg and J. L. Wortman. Localities, John Day river, Bridge creek, and Camp creek of Crooked river.

Merycochœrus leidyi Bettany.

Quarterly Journal of the Geological Society of London, xxxi, 1875, p. 270; Plate XVIII.

Defined and discussed under the preceding species.

John Day epoch, Oregon; Lord Walsingham. John Day river.

Merycochœrus chelydra, sp. nov.

This species is known to me by a skull without mandible, which is entire, except that the extremity of the nasals and the border of the pre-maxillary bones are broken off. It is unfortunate that I have no second skull to confirm its characters, but my numerous specimens of the *M. superbus,* to which it is most nearly allied, do not present any approximations which suggest transitions between the two.

The striking character of this cranium is its great breadth at the temporal region, as compared with its length and other dimensions. The forms of the otic bulla differ from those of the *M. superbus.* One method of expressing the width of the skull is as follows. The point of the frontal bone which is equidistant from the supraoccipital notch and the external edge of the zygomatic arch, measured in a horizontal plane, is directly above the posterior or nareal palatal border, when the skull rests on the teeth. In the *M. superbus,* in the most robust examples, this point is above a point which is a good deal nearer to the line of the anterior edge of the glenoid surfaces than to the palatal border, and at least 30mm. posterior to the latter. That this relative shortness of the basicranial axis is not due to a shortening posterior to the glenoid surfaces, as is the case in *M. leidyi* Bett., is proven by the fact that a line drawn through the postglenoid and paroccipital process makes an angle of 90° with the middle line, as in *M. superbus.*

The muzzle is compressed and its superior surface is regularly rounded

The side is divided by the gentle convexity continued forwards from the malar region. Below this and above the premolars the face is concave. Above it the preorbital fossa is well marked, though not deep, and gradually fades out anteriorly. The interorbital region is flat, as in *M. macrostegus*, and the supraorbital border is not decurved, as it is in *M. superbus* and *M. montanus*. The supraorbital and preorbital borders of the front are, however, not continuous as in *M. macrostegus*, though nearly in the same line, which they are not in *M. superbus*. The orbits are more oblique than in *M. superbus*, looking more upwards and forwards, and their vertical exceeds their transverse diameter. The malar bone though oblique, is more vertical than the orbit below the latter, and has an uninterrupted gently concave surface. The postorbital bridge is narrow, and consists one-half of the malar and one-half of the frontal bones. The inferior edge of the malar is thin and is slightly convex downwards, and passes behind the protuberant squamosal at a point behind the line of the postfrontal process. The anterior extremity of the squamosal is not protuberant below the orbit and only begins to rise gradually below the line of the postfrontal process. It then expands rapidly downwards and outwards in a strong curve, with its flat surface looking upwards as much as outwards. After making a short downward turn it rises steeply, contracting gradually inwards, and presenting a convexity posteriorly, with its truncate edge looking outwards. Its apex is nearly on a level with the sagittal crest. The inner or descending edge of this process is concave, so that the apex overhangs a little the posterior outlet of the temporal fossa. The anterior temporal angles are strongly marked and unite into a sagittal crest. The edge of the crest is thickened, so that its section is a letter T.

The supraoccipital bone presents a wide flat convexity above the foramen magnum, in distinction from the stronger convexity of *M. superbus*, and the still stronger of the *M. macrostegus* and *M. montanus*. As in the other species, the posttemporal (= lateral occipital) crests are only present at the upper half of the occiput. Between them there are two ligamentous or tendinous insertions, but no median keel. The exoccipital and posttympanic borders form a tuberosity below the meatus auditorius, which passes upwards into a short convex posttemporal crest. The paroccipital process nearly reaches the postglenoid by its anterior external edge. The tympanic is complete, is not keeled below, and extends itself as a lamina over the posterior side of the postglenoid process. The section of the basioccipital is open V-shaped. The inferior flat surface of the sphenoid is produced backwards in a wedge-shaped prominence to a line connecting the anterior edges of the paroccipital processes. It has the same form in *M. macrostegus*, but in three skulls of *M. superbus*, where it is visible, the apex of the wedge does not extend posterior to the middle of the otic bullæ. The bullæ are small and subconical, and reach as far as the anterior edge of the postglenoid process. In the latter the transverse diameter exceeds the anteroposterior, which exceeds the vertical diameter. This process and the otic bulla are of about equal protuberance. In four

crania of the *M. superbus*, where both are well preserved and exposed, the bulla is considerably more prominent than the postglenoid process. The glenoid surface is well-defined and equally wide at both extremities, The inferiorly presented surface of the zygomatic arch, is wider than in any of the other species, including examples of *M. superbus* of superior dimensions in other respects. The surface is rugose. The length from a line connecting the median external columns of the last superior molar, to the posterior nareal border, enters three times into the distance from the latter to the border of the foramen magnum. In *M. superbus* it goes three to three and a half times; in *M. macrostegus* and *M. montanus* once only. Behind the molars the produced palatal roof is more concave than between the last two true molars. The palate becomes then more concave (convex), and between the first premolars and canines becomes flat, and expands laterally. The nareal fissure is not much contracted between the premaxilliaries.

The infraorbital foramen is above the anterior half of the superior fourth premolar, and is of moderate size. The frontal foramina are separated by a space which is less than half as wide as that which separates each one from the superciliary border. There is no supraorbital notch. The incisive foramina are large, are wider than long, and approach close to the bases of the canine teeth. The palatine foramina are minute or obsolete. The foramen ovale is isolated and is opposite the junction of the glenoid and postglenoid surfaces. The jugular foramen is isolated by the extensive contact of the otic bulla and the basicranial axis. Perhaps the condyloid foramen is included in it, as I do not find it in the usual position. The animal is so old that no sutures are visible.

The teeth are not all cleared from the matrix, which is hard and brittle. The first true molar is much worn. The first premolar is two-rooted, and is separated from the canine by a diastema equal in length to the long diameter of its crown.

Measurements.	M.
Length from occipital condyle to front of canine tooth.	.300
" " " " " postglenoid process...	.041
" " " " " postfrontal process. ..	.132
" " " " " palatonareal border..	.118
" " " " " end of last molar.....	.146
Diameters of orbit { vertical.	.0455
Diameters of orbit { transverse	.039
Depth of malar bone at middle of orbit.	.034
" " zygomatic process to glenoid face behind.....	.088
Width of top of muzzle at preorbital fossa	.043
" at middle of supraorbital border.	.094
" " malar below orbit.	.160
" " middle of zygomatic arch.	.254
" of occiput at superior crests.	050

Measurements.	M.
Elevation of occiput from foramen	.084
Width of occipital condyles	.063
Width of occiput at condyles	.095
Depth of skull at right angles to profile at glenoid face	.095
" " " " " " orbit	.087
" " " " " " P-m 1	.075
Length of superior dental series with canine	.159
" " premolar series	.061
" " true molar series	.065
Diameters M. i { anteroposterior	.0180
Diameters M. i { transverse	.0185
Diameters of canine { anteroposterior	.016
Diameters of canine { transverse	.020
Diameters P-m. ii { anteroposterior	.0155
Diameters P-m. ii { transverse	.090
Width of palate at m. i	.044
" " P-m. i	.057

The typical specimen was found on the John Day river, Oregon, by Mr. J. L. Wortman.

Merycochœrus macrostegus, sp. nov.

I have been able to discover in my collection as yet, but one cranium with entire mandible of this species. The very marked characters of this skull are such that no farther evidence of its reference to a peculiar species is needed. Its affinities, as expressed in the analytical key which accompanies the general discussion of this genus, are with the *M. montanus.* This is shown in the posterior positions of the infraorbital foramen, and of the posterior nares. As peculiar characters may be added the form of the frontal plane and of the otic bulla ; also the prolongation of both the premaxillary and supraoccipital regions, and the forms of the zygoma, the angle of the mandible, and the first inferior premolar tooth. The skull reaches a greater length than that of any species, excepting the *M. montanus,* but is not nearly so robust as in the *M. chelydra,* resembling in this respect rather the *M. superbus.*

The muzzle is compressed, and there is a decided concavity just above the second premolar, above which the surface is a little convex. Above the infraorbital foramen, the face is abruptly convex, the convexity sloping upwards to the base of the median ridge formed by the convex nasal bones. Behind this the side of the face is a plane which slopes outwards as it descends, which is only interrupted by the rather small, but well defined, preorbital fossa. The fossa is better defined in front than in the other species, but I do not know whether the character is constant. The front is a transverse diamond-shaped area, bounded posteriorly by the anterior temporal ridges, and anteriorly by the lines of the supraorbital borders

produced to their point of intersection with each other. Such point of intersection is above the second true molar in this species; in *M. superbus* and *M. chelydra* it is above the posterior part of the second premolar. The area in these species enclosed by the lines in question is half as long again as wide, instead of wider than long by 18mm. This difference is partly caused by the greater prominence and flatness of the postorbital angle of the frontal bone in the *M. macrostegus*, and the more anterior direction of the orbits, which I may add have none of the tendency to superior direction seen in *M. chelydra*. The wide triangular area thus enclosed on its external sides by the orbit and anterior temporal ridges, is perfectly flat. Such an area can hardly be defined in the other species, and the surface there is rounded and descending. The malar bone is deep, flat and a little oblique outwards, and the rim of the orbit projects a little, giving it a slight concavity. The orbit is deeper than wide. The anterior part of the zygomatic process of the squamosal is not protuberant below the orbit, but gradually rises outwards posteriorly, attaining its greatest expansion opposite the middle of the zygomatic foramen; above, its course is for a time parallel with the middle line of the skull. The form of the zygomatic arch is more like that of *M. chelydra* than any other species, but it is not so much expanded, especially anteriorly. Its inferior and posterior surface is, however, widened, making an angle with the external or marginal surface, which is in turn separated by an angle from the superior and anterior surface; at the middle of the arch the superior surface has a width of 19mm., and the external a width of 23mm. The posterior angle rises to the plane of the summit of the sagittal crest, and the apex, which is less than a right angle, stands above the external base of the postglenoid process. The preglenoid border is not exactly at right angles with the middle line, but makes a slight angle outwards and forwards. The long diameter of the zygomatic foramen is parallel with it. The ridge along the pariëtosquamosal suture is insignificent. The supraoccipital region is very prominent, and as in the other species of this genus is narrowed below by the disappearance of the posterior temporal or exoccipital crests. They are continued downwards and disappear, leaving a wide convex surface above the foramen magnum. This is separated by the usual lateral fossa from the posterior temporal angles.

The coössified mastoid and paroccipital processes much contract the auricular fossa below, but do not close it. The latter is contracted at the base of its terminal part, and is distally slender. The otic bulla is the smallest known in the genus, it is compressed and oval, and not produced beyond the postglenoid processes either forwards, backwards or downwards, in this differing much from the *M. montanus*. It is separated by wide and equal intervals from this process, the glenoid surface, and the basisphenoid. It sends a process backwards and inwards to a sutural junction with the basioccipital bone. The tympanic bone is flat below, and is united with the posterior base of the squamosal by a flat expansion. The postglenoid process is robust, and has the height and thickness equal,

while the width exceeds both. The basioccipital bone is prominently keeled on the middle line, so that the section is a V of a more compressed character than the section of the same in *M. superbus.* The median plane of the sphenoid is prominent, and is continued as a wedge with the apex opposite the posterior borders of the otic bullæ. The palatine borders are parallel, except where they form on each side an open angle at the junction of the descending process of the sphenoid, which is here directed forwards. Its external border is distinct from that of the palatopterygoid plate, and makes a groove with it. The maxillary bone is not produced posterior to the notch on either side of the base of the posterior production of the palatine bones. The middle line of the latter is deeply concave opposite the former, and the palate is also especially concave between the first true molars. The palate is flat between the first and second premolars. The inferior surface of the squamosal process of the zygoma is roughened for the origin of the masseter muscle. The inferior edge of the malar comes from its inner side, and is narrow and with a median groove. Its inferior edge is continued as a ridge of the maxillary as far as opposite the anterior lobe of the second true molar. The maxillary bones are more produced anteriorly than in any of the other species. The apex of the nasal bones stands above the posterior border of the canine in this species; above the anterior edge in *M. superbus*, *M. chelydra* and *M. leidyi* (fide Bettany). The posterior border of the nares is above the anterior part of the first premolar in the three species named, except *M. chelydra* where it is over the posterior edge of the canine: in *M. macrostegus* it is above the posterior edge of the longer first premolar.

The infraorbital foramen is large, and its posterior border is above the anterior root of the first true molar. The incisive foramina are large, and each one is a little longer than wide. The nareal opening contracts gradually to its inferior apex. There is a considerable maxillary foramen opposite the middle of the fourth superior premolars. The posterior nareal is not large; its anterior outline is regularly concave. Its lateral (sphenoid) borders reach to opposite the anterior faces of the postglenoid processes and bound the foramen ovale on the inner side. The latter is round, is rather small, and is opposite the middle of the postglenoid surfaces. The foramen rotundum on the other hand is large and vertically oval, and is bounded below by a transverse prominence of the base of the alisphenoid bone. It probably includes the sphenoörbital foramen, a foramen anterior to its inferior border probably communicating with the nareal chamber. The optic foramen is small, and is situated opposite the anterior two-fifths of the zygomatic fossa and a little above the line of the apex of the foramen ovale. The foramen lacerum is ovoid and not large. The posterior foramen lacerum is a transverse sigmoid, one extremity being the jugular foramen. The mastoid and postpariëtal foramina are of moderate and equal sizes. No postsquamosal or supra- or postglenoid foramina.

The animal described is too old to exhibit sutures.

The mandible possesses some distinctive characters. The angular border is not prominent posteriorly, extends forwards below, and projects below the general level of the inferior border of the ramus. Neither of these characters is observable in the only ramus of the *M. superbus* in which the lower part of this border is well preserved, but in some others of that species the superior part of the border is much as in *M. macrostegus.* The inferior edge of the ramus is straight, but there is a descending tuberosity of the symphysis which may be an individual peculiarity. The symphysis is very concave in profile, and the incisive border is produced in accordance with the prolonged muzzle. In the *M. superbus* it is sometimes convex, sometimes a little concave, but not so much so as in this jaw. The coronoid processes are small and slightly everted. The inner ridge of its anterior base is more prominent than the exterior, and encloses a fossa with it. The masseteric fossa is not noticeable. There is one large mental foramen below the third premolar. The dental foramen is large and oval, and when the mandible stands on a level surface is opposite the middle lobe of the third inferior molar tooth.

In dentition this species is distinguished by the relatively large size of the premolar teeth, of which the first, second and third are two-rooted in both jaws. Both the first and second in the upper jaw have short diastemata anterior and posterior to them, the largest being behind the canine tooth, and nearly as long as the premolar's crown. All the teeth are a good deal worn in the specimen. One can see two internal cingula inclosing fossæ on the third premolar. The true molars increase in size rapidly posteriorly and the third has a well-developed external heel. The molars have no internal cingula ; these are present in five of seven skulls of the *M. superbus* where these parts are cleaned. The most noteworthy point in the mandibular dentition is a very rudimental character of the internal vertical ridge of the crown of the first premolar. The posterior fossa of the fourth premolar is closed, and the anterior remains open, on wearing. In *M. superbus* both are closed in the specimen where visible. The anterior inner wall is represented in the second and third premolars by a cingulum. No cingula on the true molars. First premolar very robust, its section lenticular.

Measurements.	M.
Axial length from occipital condyles* to premaxillary border	.345
Axial length from occipital condyles to postglenoid process	.045
Axial length from occipital condyles to postfrontal process	.138
Axial length from occipital condyles to palatonareal border	.100

*The occipital condyles are broken off in the specimen, so I measure from the superior border of the foramen magnum, which is, in the other species, in the vertical line of the occipital condyles.

Measurements.	M.
Axial length from occipital condyles to end of last molar	.058
Diameters of orbit { vertical	.044
Diameters of orbit { transverse	.036
Depth malar bone at middle of orbit	.037
" zygomatic process to glenoid face behind	.077
" skull (right angles to profile) at glenoid face	.088
" " " " " " orbit	.088
" " " " " " P-m. i	.068
Elevation of occiput from foramen magnum	.084
Width top of muzzle at preorbital fossa	.038
" at middle supraorbital border	.109
" " postfrontal process	.137
" " malar below orbit	.166
" " middle of zygomatic arch	.243
" of occiput at superior crests	.050
" " " condyles	.101
Length superior dental series, with canine	.177
" " premolar series	.092
" " true molar series	.083
Diameters canine { anteroposterior	.013
Diameters canine { transverse	.018
Diameters P-m. i { anteroposterior	.017
Diameters P-m. i { transverse	.075
Diameters m. i { anteroposterior	.019
Diameters m. i { transverse	.0215
Diameters m. iii { anteroposterior	.038
Diameters m. iii { transverse (at middle column)	.029
Width of palate at P-m. i	.061
" " m. i	.053
" " middle of zygomatic arch	.047
Length of inferior dental series with canine	.179
" " premolar series	.088
" " true molar series	.088
" of ramus to posterior edge	.279
Depth of ramus mandibuli at condyle	.124
" " " m. iii posteriorly	.073
" " " m. i posteriorly	.048
" " " P-m. i (front)	.015
Diameters inferior P-m. i { anteroposterior	.019
Diameters inferior P-m. i { transverse	.0125
Diameters " P-m. iv { anteroposterior	.021
Diameters " P-m. iv { transverse	.013
Diameters " m. i { anteroposterior	.020
Diameters " m. i { transverse	.014

Measurements. M.

Diameters inferior m. iii	anteroposterior	.044
	transverse	.018

This fine species is from the John Day epoch of the Miocene. The typical specimen was found by my assistant, Charles H. Sternberg, on Bridge creek, Oregon. Much credit is due Mr. Sternberg for his unwearied exertions in the cause of science, which have been continued through many occasions of risk and discomfort.

Merycochœrus montanus, sp. nov.

This large animal is represented in my collection by a nearly entire skull with parts of both mandibular rami complete. Rami of another individual give the entire dentition of the lower jaw except the incisors. A third individual is represented by a symphysis with premolars, canines and incisors, and by various parts of the skeleton, including feet. Of the cranium mentioned, the muzzle to the preorbital fossa and the palate to the first true molar are wanting. The region of the larmier is lost, but the general resemblance of the species to the *M. macrostegus* in other respects, leads me to suspect that it is absent, and that the *M. montanus,* is rightly referred to the genus Merycochœrus. This course is indicated by the structure of the superior molar teeth, which have the character of those of this genus, rather than that found in Merychyus. That is, the posterior internal crescent sends its anterior horn to the external wall of the crown, thus cutting off the posterior horn of the anterior crescent. Dr. Leidy has shown that the reverse is the case in the *Merychyus major;* that is that the posterior horn of the anterior crescent reaches the external wall of the crown, cutting off the anterior horn of the posterior crescent. I have observed that this is also the case in the other species of Merychyus which have come under my notice.

The posterior position of the infraorbital foramen and the greatly produced palate distinguish this species from those of the John Day epoch, excepting the *M. macrostegus,* while in the *M. rusticus* and *M. proprius,* the infraorbital foramen is still further posterior. The palate of these species is unfortunately unknown.

The part of the maxillary bone posterior to the infraorbital foramen is nearly flat, and the proximal part of the malar bone is also flat. The inferior edge of the latter is narrow and is marked by a groove which terminates anteriorly in a shallow fossa. The ridge continuous with this edge terminates above the anterior lobe of the second true molar. The zygoma as far as the anterior border of the glenoid cavity is slender, and not convex, but flat in every direction, nor is it decurved as in *M. superbus.* The zygomatic foramen is relatively much smaller than in that species. Its posterior or preglenoid boundary is not at right angles to the sagittal crest as in that species, but is oblique outwards and forwards at an open angle. The obtuse median edge of the zygoma looks upwards, not outwards as it does in *M. superbus* and *M. macrostegus,* and the superior expansion is

opposite the internal extremity of the glenoid face, instead of the external as in *M. superbus*, or the middle, as in *M. macrostegus.* The border descending to the supraauricular crest is thin and vertical in direction, and the superior angle stands above the middle of the postglenoid process, not external to it, as in the two species above named. The postglenoid process is robust and has a convex posterior face. The paroccipital process is long and acuminate. An external truncate ridge on the front of its base partially embraces the meatus auditorius, and curving forwards becomes the anterior edge of the process, which is separated from the postglenoid by but a narrow interval. The tympanic bone forms a tube more distinct from the surrounding regions than in the other species here described, and has a longitudinal inferior keel, which is not visible in the *M. superbus* and *M. macrostegus.* It is separated at the meatus by but a short interval from the base of the postglenoid process. The supraauricular and mastoid crests unite and form a short acute crest, which does not continue into a prominent posttemporal, but descends into a mere angle, which continues as a fine line to the convexity of the true posttemporal crest above. The latter arises from the bifurcation of the sagittal crest, and after a strong convexity descends with its fellow to a narrow prominent convex ridge, which rises from the foramen magnum, Thus the occiput on either side of this prominent middle line is deeply excavated, and the fossa is bounded on each side and anteriorly by the low posttemporal angle, and the more prominent mastoid ridge. There is no median keel. The median ridge of the occiput is more prominent and not so flat as in *M. superbus*, but is more as in *M. macrostegus.* The sagittal crest is well developed, and has a straight superior border, which is not thickened as in *M. chelydra.* The anterior temporal ridges are represented by an angle which is nearly right. The superior squamosal suture is marked by a prominent ridge. The front is gently convex transversely, and the supraorbital border is more strongly decurved than in *M. superbus*, which are more so than in *M. macrostegus.*

The basicranial axis makes a strong angle with the basifacial as in the other species of the genus, showing that the face was presented obliquely forwards, as in the peccary. The section of the basioccipital bone between the paroccipital processes is V-shaped, owing to the presence of a strong median angle. In *M. macrostegus* this bone is similar, but in *M. superbus* it is much flatter, and there is a weak median keel. The sphenoid is in line with the occipital and has a broadly rounded-truncate inferior face. The otic bullæ are large and compressed. They extend from the middle of the base of the paroccipital process to considerably in advance of the postglenoid process, and approach very near to the glenoid surface. The interval which separates them is small, equaling one-fifth the anteroposterior diameter of the bulla. This is very different from the *M. macrostegus*, where the space between the glenoid surface and the bulla, is equal to the anteroposterior diameter of the latter near the middle. As already pointed out, this species agrees with the species just named in the

great prolongation of the palatal floor of the nareal cavities. The distance from the foramen magnum to the nareal border equals the distance from the latter to the line connecting the median external vertical crests of the last superior molars. In *M. superbus* the former measurement is two and one-half times as great as the latter.

The mandible shows the nearer relationship to the *M. macrostegus* than to the *M. superbus*, in the anterior elongation and greater relative size of the premolar teeth. It agrees with the former in having the profile of the symphysis concave, and not convex as in *M. superbus*. It is less concave in my single specimen than in that of *M. macrostegus*. The position of the posterior extremity of the symphysis is below the middle of the third inferior premolar. The coronoid process is low, and of small size. Its compressed convex apex is directed at an angle of 45° from the middle line outwards and forwards. Its anterior face soon widens out and the internal edge becomes much more prominent than the external, with which it encloses a shallow, subtriangular, subvertical fossa. The external border is continuous with the external alveolar border. The masseteric fossa is small and has no distinct inferior border, and does not descend below the level of the line of the middle molar teeth. The inferior border of the ramus is nearly straight. The inferior incisive alveolar border is much more strongly convex than in the *M. superbus*. The condyle has the posterior articular face on the inner side, as in other species.

The infraorbital foramen is large and is above the anterior part of the first true molar tooth. The meatus auditorius is small. There are two postparietal foramina on the pariëtosquamosal suture. No supraglenoid or postglenoid foramina. There are two mental foramina, one not small below the anterior part of the first true molar, the other, quite large, below the posterior part of the third premolar. The dental foramen is situated on a level with the alveolar border and well posteriorly, its anterior border being a little in front of a line dropped vertically from the apex of the coronoid process. It is thus similar in position to that of *M. macrostegus* and different from that of *M. superbus*, where it is above the line of the apices of the molars, and is posterior to the line dropped from the apex of the coronoid.

In the superior true molars, the size increases rapidly posteriorly. The third is relatively of more elongate form than the first, but the posterior external column is but little produced. The other vertical ridges are quite prominent. The external faces of the external lobes are nearly flat. Besides the relation of the adjacent horns of the internal crescents already mentioned, the posterior horn of the posterior crescent in the first and second molars is cut off from the external wall of its own crown by the anterior horn of the anterior crescent of the crown next posterior. This does not exist in worn molars of *M. superbus* and *M. macrostegus*, but is observable in little worn teeth of the former. It does not look as though the character would disappear with wear in the *M. montanus*. The only

trace of cingulum on the superior molars is on the inner base of the anterior lobe, where it is weak, and in the interspace between the internal lobes, where it is a narrow tubercle. Enamel obsoletely vertically striate. It is wanting on the external side of the internal crescent, as Leidy has shown to be the case in certain species of Merychyus. The fifth lobe of the last inferior molar is well developed and has its two crescents separated by a groove. The adjacent horns of the external crescents are of about equal length. No cingula, except a trace on front and rear of crowns, and a tubercle between the bases of the external lobes. The fourth premolar has two fossæ isolated, one anterior to and the other posterior to the principal apex, which is double, and anterior to the middle. Before wear, each of these fossæ opens inwards. The crown of the third premolar has its inner face unequally divided by a crest behind the middle. Posterior to this the space is occupied on the inner side by two shallow fossæ of which the posterior is the narrower. Anterior part of inner face of crown concave. One principal angular cusp. The second premolar has a compressed triangular crown with a long base, and a weak vertical ridge on the internal side. The first premolar is a very robust tooth with a straight posterior border directed at 95° forwards, and is vertically truncate in the specimen by friction with the canine. Section of crown lenticular, rounded in front.

Measurements.	M.
No. 1.	
Length from occipital condyle to postglenoid process...	.049
" " " " " postfrontal process...	.135
Width of occiput at posttemporal crests.	.054
" " " condyles.	.102
Elevation of occiput above foramen magnum.	.084
Length from foramen magnum to palatal border.	.060
Width between apices of otic bullæ.	.042
Length from inferior m. iii to apex of coronoid process.	.075
" of superior true molar series.	.084
Diameters m. i { anteroposterior	.026
Diameters m. i { transverse (at middle rib)	.025
Diameters m. iii { anteroposterior.	.034
Diameters m. iii { transverse (at middle rib).	.025
Length of inferior true molar series.	.085
Diameters P-m. iv { anteroposterior.	.0205
Diameters P-m. iv { transverse behind.	.015
Diameters m. i { anteroposterior	.022
Diameters m. i { transverse.	.016
Diameters m. iii { anteroposterior.	.040
Diameters m. iii { transverse..	.022
No. 2.	
Length of ramus mandibuli from incisive border to condyle (oblique).	.280

Measurements.	M.
Length of dental series (straight line)	.191
" from last molar to apex of coronoid	.0735
" of premolar series	.085
" " true molar series	.084
" " second premolar on base	.021
" " first premolar on base	.0225
Depth of ramus at coronoid	.044
" " " end of m. iii	.073
" " " middle m. i.	.056
" " " P-m. i. vertically	.034

The specimens of this species were found by Mr. J. C. Isaac in the Ticholeptus beds of Deep river, Montana, during his Expedition of 1880.

Merycochœrus rusticus Leidy.

Report U. S. Geological Survey Terrs., 1873, i, p. 199, Pl. III, figs. 1–3; VII, figs. 1–5; XX, figs. 9–81. Proceedings Academy Philadelphia, 1870, 109.

The smallest species, characterized among other things by the closure of that part of the nareal fissure which separates the premaxillary bones below. According to Leidy's figure above quoted, the depth of the middle line of the undivided premaxillary is greater than the width of the bone, a state of things not approached by any of the species of this genus described in the preceding pages. The premaxillary in the *M. proprius* is not described.

From the ? Ticholeptus beds of the Sweetwater river, Wyoming.

Merycochœrus proprius Leidy.

Proceedings Academy Philadelphia, 1858, p. 24; Extinct Mammalia Dakota and Nebraska 1869, p. 110; Pl. X.

This large species represents the extreme form of the genus in the anterior position of its dental series as compared with the braincase. The zygomatic arch and infraorbital foramen are therefore more posteriorly placed than in any other species. The premaxillary bone is more prominent than in any other, and the incisor teeth have relatively larger dimensions. The size is about that of the *M. superbus.* I have not seen any other than the typical specimen.

From the Ticholeptus beds at the head waters of the Niobrara river, Nebraska.

MERYCHYUS Leidy.

Proceedings Academy Philad'a, 1858, p. 24, (nomen nudum). Extinct Mammalia Dakota and Nebraska, 1869, 115. Report U. S. Geological Survey Terrs. i, 1873, p. 202. Cope, American Naturalist, 1884, p. 281. *Ticholeptus* Cope, Bulletin U. S. Geolog. Survey Terrs., 1878, p. 380.

Premaxillary bones coössified; otic bulla swollen; a vacuity between

the maxillary, lachrymal, and nasal bones, or larmier. Nasal bones normal. First inferior premolar caniniform.

This genus has not been defined prior to the present article, although some characters common to the species of the genus known to him, have been given by Leidy. As now defined it is identical with genus *Ticholeptus* Cope. This group was distinguished by the presence of a larmier, a character whose presence in the species of Merychyus has been hitherto unknown. It is not yet reported indeed as present in any of the original species of the latter, but I think that there can be no reasonable doubt of its presence there. A character found by Leidy in the *M. major* I find to be present in one or more of the superior molar teeth in all the species. The posterior horn of the anterior internal crescent cuts off the adjacent or anterior horn of the posterior internal crescent from contact with the inner side of the external wall of the crown. It is the anterior horn of the posterior internal crescent which reaches the external wall, in the genera Merycochœrus, Eucrotaphus and Oreoden. In Leptauchenia the arrangement is generally as in Merychyus; see under the head of that genus.

This genus is confined to the Upper Miocene beds, the Ticholeptus and Loup Fork epochs. In size the species range from medium to large, the *M. major* equaling any species of the family in dimensions. They are distinguished as follows:

I. True molar teeth not prismatic.

Infraorbital foramen above fourth premolar; malar bone shallow; squamosal with superior zygomatic angle anterior; true molars M. .042.................................*M. pariogonus.*

II. True molar teeth more or less prismatic.

a. Infraorbital foramen above third premolar.

Larmier a slit; front narrow.................*M. arenarum leptorhynchus.*

aa. Infraorbital foramen above fourth premolar.

β. Zygomatic arch vertical, and with posterior angle small and rounded.

Larmier triangular; front wide; true molar series M. .044; face convex...................................*M. arenarum arenarum.*

ββ. Zygomatic arch expanded horizontally; posterior angle strong, acute.

Larmier large; true molars .051.........................*M. zygomaticus.*

ββ. Zygomatic arch unknown.

Facial plate generally concave; true molars M. .045..........*M. elegans.*

True (inferior) molars, M. .069..............................*M. medius.*

True (superior) molars (m. iii inferred), M. .095...............*M. major.*

Of the above species, the *M. arenarum* and *M. zygomaticus* are known from entire skulls. In the first named, the foramen infraorbitale appears to be partly above the posterior edge of the third premolar, as well as above the anterior edge of the fourth.

Merychyus arenarum Cope, sp. nov. Sub-species **leptorhynchus** Cope.

This species is represented by a skull which lacks of completeness only the extremity of the muzzle and the angles of the lower jaw. Its size is about that of the *Oreodon culbertsoni* or of the *Merychyus elegans*. The confluence of the premaxillary bones shows that the place of the species is with the last-named genus, and the sigmoid flexure of the masticating line of the superior dentition is a point of resemblance to the species of the same. The position of the external infraorbital foramen is one degree further posterior than in the species of Oreodon, and agrees with the position in two other species of Merychyus (*M. arenarum* and *M. pariogonus*), which is more anterior than in the other species of the genus. The foramen is in fact quite identical in position with that seen in most of the species of Eucrotaphus, to which genus the above named species must be regarded as the nearest in the genus to which they belong.

As in other species of the genus, the malar bone is deeper and less prominent laterally than in those of Oreodon. The preorbital fossa is wider and shallower. The orbit is closed behind.

The premaxillaries are convex in every direction, least so transversly. The fissure which separates them is quite narrow, and is separated from the alveolar border by a rather narrow isthmus of uninterrupted bone. At the canine tooth the direction of the surface becomes longitudinal by an abrupt turn, and the side of the face above the second premolar is uninterruptedly gently concave. The lateral convexity which bounds the preorbital fossa below, appears above the third superior premolar, and becomes more prominent posteriorly as it passes into the flat surface of the malar bone. The anterior orbital border is prominent and thin, and does not develop a distinct tubercle, although its edge is roughened. The profile of the muzzle is a straight line descending gently from the interorbital region. Above the middle of the orbits the frontal bones are gently convex; on the line of their anterior border, there is a concavity of the median line. The superior face of the nasal bones is flat, and is peculiarly narrowed, especially posteriorly, where the large preorbital fossæ approach each other.

The anterior temporal ridges are well marked, and after a gradual approach unite into a sagittal crest, which has a gently convex rising profile. After the posterior bifurcation of the latter, the convex posterior temporal crests do not project beyond the occipital condyles when the inferior edge of the lower jaw rests on a horizontal plane, as in so many other species of this genus and of its allies. These crests continue without interruption above the auricular meatus to the posterior base of the postglenoid process. As compared with the *Oreodon culbertsoni*, the postorbital part of the cranium is short; it is also shorter than in any other species of Merychyus. Thus the length from the posterior border of the orbit to the convexity of the

posterior temporal crest, is as long as from the former point to the anterior base of the first premolar. In the *Oreodon culbertsoni*, the same measurement is equal to the length from the same point to the anterior base of the third incisor. This shortening posterior to the orbit is seen to involve the zygomatic fossa as well as the region posterior to it. Thus the horizontal diameter of the orbit in the *M. leptorhynchus* is exactly equal to the distance between the posterior border of the same and the anterior edge of the glenoid cavity. The posterior part of the superior edge of the squamosal zygomatic process is thin and strongly convex. The apex of the convexity is above a point just anterior to the posterior border of the glenoid cavity. The posterior edge of the process is nearly vertical, and if continued would reach the middle of the base of the postglenoid process. The latter is compressed and rather elongate, and its convex edge has considerable transverse extent. The paroccipital process is long and is flat on its posterior face. The postorbital process of the frontal is elongate wedge-shaped, with its truncate apex below joining a slight elevation of the malar bone, which is much less prominent than in *Oreodon culbertsoni*. It presents an angle outwards and forwards, as the orbital border. The anterior half of the zygomatic process of the malar bone is rounded-truncate below. The glenoid surface is plane transversely, and slightly convex, rising backwards, anteroposteriorly. The anterior border of the squamosal bone is not developed into a ridge.

The frontal bone extends forwards on either side of the nasals, forming a narrow process above the lachrymal bones. It overlaps the superior edge of the maxillary, of which a narrow splint appears between it and the nasal. The nasals are rather narrow, and each has the posterior border rounded. The latter fall above the middle of the first true molar tooth when the inferior edge of the mandible is horizontal. The lachrymal bone has greater anteroposterior than vertical diameter, extending nearly to the line of the infraorbital foramen, or much in advance of its position in *Oreodon culbertsoni*, *Eucrotaphus jacksoni*, or *Merycochœrus superbus*. The malar bone has a correspondingly large anterior extension, reaching to above the posterior part of the fourth premolar. It does not extend so far in the three species just named. The zygomatic process of the squamosal is more deeply received into the malar bone than in any of the three species mentioned, reaching to below the posterior third of the orbit.

The larmier in this species is small, and its anteroposterior diameter is more than twice as long as the vertical. More than half of its inferior border is formed by the maxillary bone. As it is exhibited in the specimen, its superior border is formed by the ascending process of the maxillary bone ; whether this is overlapped by the laminar process of the frontal so as to bound the foramen, when in a perfect condition, is uncertain. The posterior edge of the larmier is the lachrymal bone. The external *foramen infraorbitale* is on one side double. The supraorbital foramina form notches at the anterior edge of the supraorbital border. The frontal

foramina are well separated from each other, as in the species of Merycochœrus. The space between them is about equal to that between each one and the superciliary border. There is a large postpariëtal foramen near the pariëto-squamosal suture. If the supraglenoid foramen be present it is not distinguishable in the specimen. The orbit is rounded subquadrate, with the inferior anterior angle a little produced.

The ascending process of the mandible is relatively elevated. The horizontal ramus narrows rapidly anteriorly, and the symphysis mandibuli is produced so as to rise at a very low angle. The alveolar portion is horizontal.

The superior incisors are small and their apices are but little expanded, the external the most so. They are directed vertically downwards. The superior canine is quite small; its crown exceeds in length that of the first premolar by but little, and is directed a little posteriorly as well as downwards. The roots of the first premolar are not as well distinguished as in many other species, and are united in their extra-alveolar part at least. The same is true of the second premolar. The apex of the cutting edge is in line with the anterior border of the crown; the rest of the edge rises obliquely backwards. In the third premolar there is a slight bevel in front of the apex, which is much better developed on the fourth. These teeth are more truncate than the corresponding ones of the species of Oreodon and Eucrotaphus, and the larger species of Merycochœrus. The external faces of P-m. i and ii are convex; that of P-m. iv is concave, but without the reverted vertical borders seen in *Oreodon culbertsoni*. The first true molar has long roots and a short crown. The last two molars have crowns of a more elongate character, with well developed anterior and middle ridges. The latter are not so prominent as those of the molars of the *Merychyus zygomaticus*.

The inferior incisors are directed upwards at an angle of about 30°. They are similar and closely packed. The inferior canine is in close contact with the third incisor, from which it differs in its larger, leaf-shaped crown. The inferior first premolar is a slender one-rooted caniniform tooth, with narrow crown and acute apex. The second premolar is one-rooted, and has a leaf-shaped crown, with acute-angled apex. The third is two-rooted, and has a wider and nearly symmetrical crown. The fourth is much larger, and its elongate crown laps inside of that of the third. Its low angular apex is median. The last inferior true molar is disproportionately larger than the others. No external cingula.

Measurements of Skull.	M.
Length from occipital condyle to premaxillary border..	.161
" " " " " postglenoid process...	.030
" " " " " postfrontal process...	.078
" " " " " preorbital border.....	.130
Diameters of orbit { vertical........................	.0250
Diameters of orbit { transverse......................	.0255

Measurements of Skull.	M.
Depth of malar bone at middle of orbit	.0195
" " zygomatic process at glenoid face (greatest)	.021
Width of top of muzzle at larmier	.0175
" at middle of supraorbital border	.051
" " malar bones	.077
" " zygomatic processes of squamosal	.0795
" of occipital condyles	.031
Elevation of occiput, including condyles	.054
Width of occiput at middle	.033
Depth skull at right angles to profile, at glenoid face	.046
" " " " " " orbit	.049
" " " " " " larmier, exclusive of teeth	.044
Depth of mandible at condyle	.071
" " " m. ii (middle)	.025
" " " P-m. iii	.022
Length of superior dental series	.0885
" to superior P-m. i	.0130
" " " m. i	.0470
" of " m. iii	.0180
" " " canine, crown	.009
" to inferior P-m. i	.012
" " " m. i	.0425
" of " dental series	.087
" " " m. iii	.022

The unique and beautiful specimen on which our knowledge of this species rests, was found in a formation of the Ticholeptus Miocene near Laramie Peak, Wyoming Territory, by my assistant, J. C. Isaac.

Merychyus arenarum, sp. nov. Sub-species **arenarum.**

This species was more abundant than the *M. leptorhynchus* during the Ticholeptus epoch, if we may judge from the number of specimens which have been procured. I enumerate here the five most important, viz.: No. 1, A skull which lacks the muzzle as far as the preorbital fossa, and the palate as far as the third premolar, and which has the mandible complete as far as the coronoid processes, and which is accompanied by fore and hind feet and other limb bones. No. 2, A muzzle and right side of the face including the orbit, with the entire dentition, including that of the premaxillary bone, and that of the right mandibular ramus as far as the second true molar inclusive. No. 3, A skull with a part of the mandible, of an immature individual, in which the last superior molar is just appearing, and the last two temporary molars are in place, and which is accompanied by a few bones of the limbs. No. 4, Palatal part of skull with nearly all the teeth, accompanied by perfect mandible with all the teeth, and a large part of the skeleton. No. 5, A skull from which the basi-

cranial region, zygomata, and left maxillary bone, have been lost. The measurements of No. 4 somewhat exceed those of the other specimens, so that it is doubtful whether it really belongs here.

The characters which distinguish this form from the *M. leptorhynchus* are not numerous. In the first place the front and muzzle are relatively wider. Secondly, the larmier is of a different form. Instead of being a horizontal slit, it is subtriangular, with the base above, and the angle below; thirdly the canine teeth are more robust in both jaws. But the position of the infraorbital foramen is slightly variable, and the width of the front in one specimen is about as in the sub-species *leptorhynchus*. The size of the canine is not invariable. I am therefore precluded from regarding the *M. leptorhynchus* as more than a sub-species.

As compared with the *M. elegans*, the strong convexity of the side of the face distinguishes it. The convexity continues from the malar region forwards above the infraorbital foramen, and nearly reaches the nareal opening. Judging from Leidy's fig. 11, Plate XI, of the Extinct Mammalian fauna of Dakota and Nebraska, the premaxillary bone of the *M. elegans* is flatter than in the *M. arenarum*. The infraorbital foramen has a more anterior position in the latter than in the former.

The size is always a little larger than in the type specimen of *M. leptorhynchus.*

Measurements.

No. 1.

	M.
Length from occipital condyle to postglenoid process	.037
" " " " " postfrontal process	.076
" " " " " preorbital border	.105
Transverse diameter of orbit	.030
Depth of malar bone at middle of orbit	.019
" " zygomatic process at glenoid face (greatest)	.019
Width at middle of supraorbital border	.062
" " malar bones	.096
" " zygomatic process of squamosal	.100
" of occipital condyles	.034
" " occiput at middle	.036
Elevation of occiput including condyles	.054
Depth of skull at right angles to profile at glenoid face	.041
" " " orbit (exclus. teeth)	.051
" of mandibular ramus at m. ii	.030
" " " " P-m. iii	.022
Length of last five superior molars	.064
" " true molars	.043
Diameters P-m. iii { anteroposterior	.010
Diameters P-m. iii { transverse	.010
Diameters m. i { anteroposterior	.013
Diameters m. i { transverse	.013

Measurements.

No. 1.		M.
Diameters m. iii	anteroposterior	.019
	transverse	.015
Length of inferior dental series (axial)		.098
" " premolar series (axial)		.038
Long diameter of crown of canine		.007
" " " P-m. i		.0086
" " " P-m. ii		.0084
Diameters P-m. iv	anteroposterior	.012
	transverse	.009
Diameters m. ii	anteroposterior	.0147
	transverse	.010
Diameters m. iii	anteroposterior	.0223
	transverse	.010

The specimens all came from the Ticholeptus beds near Laramie Peak, Wyoming, and were discovered by my assistant, J. C. Isaac.

Merychyus pariogonus, sp. nov.

The generic position of this species is uncertain, and it may belong to Merycochœrus or even to Eucrotaphus, as its otic bullæ are inflated. The doubt as to its position is due to the fact that the anterior part of the skull of the typical specimen is lost as far back as the anterior border of the orbit, and the second molar tooth. I place it here provisionally because the internal crescents of the superior molars are arranged as in *M. major* and *M. arenarum*, *i. e.*, with the anterior crescent excluding the posterior at the point of junction of the two.

The *Merychyus pariogonus* is about the size of the *Oreodon culbertsoni.* The braincase is full, so that the internal side of the temporal fossa is strongly convex, but without very prominent ridge along the pariëto-squamosal suture. The anterior temporal ridges unite at an acute angle, but the sagittal crest is obsolete as far as a point above the posttympanic process, where it gradually rises. The posterior temporal ridge is prominent superiorly, but is not produced beyond the line of the occipital condyles. It is discontinued in the direction of the supraauricular ridge, but continues downwards as an obtuse ridge on each side towards the foramen magnum. Between this and the squamoso-occipital angle is a large open fossa which is present in the species of this genus, of Merycochœrus and of Eucrotaphus, but is wanting in *Oreodon culbertsoni.* In the obsolescence of the posterior temporal crest it agrees with the last named species, and with some of those of Merycochœrus, but differs from *Eucrotaphus jacksoni* where it is low, and from *Merychyus leptorhynchus,* where it is well developed. In the size of the lateral occipital fossæ this species exceeds any of the others of this family. Below the depression, the posterior temporal crest rises abruptly, forming a convex edge which continues downwards nearly obsolete, on the suture between the post-

tympanic and paroccipital processes. It is not distinctly continuous over the auricular meatus. The paroccipital process is elongate and acuminate, and becomes compressed so as to be anteroposterior for the greater part of its length. The auricular meatus occupies but a small part of the space between the posttympanic and postglenoid processes. It is partially enclosed by the robust rounded ledge of the squamosal bone, which separates it from the postglenoid process. This ledge is much more developed than in any other species of this family known to me. The bulla of the petrous bone is longer anteroposteriorly than transversely, and its anterior and posterior borders coincide with the anterior border of the postglenoid process, and that of the paroccipital process. The postglenoid process is robust, much as in the large species of Merycochœrus, and not compressed as in *Merychyus leptorhynchus* and *M. arenarum*. The zygomatic arch is slender. The elevation of the posterior part of the zygomatic process of the squamosal has a different form from that seen in the species last named. It is angulate, not rounded. The position of the angle is different from that in *M. zygomaticus* in being more anterior, marking a point well in front of the anterior base of the postglenoid process. The border which connects the angle with the supra-auricular crest is then not vertical as in the species just mentioned, but is oblique, and it is also somewhat concave. The malar bone is shallow and stout, with truncate edge below. The squamosal process enters it to below the posterior third of the orbit. The postfrontal process is slender, and the postorbital process of the malar is elongate, meeting the former opposite the middle of the orbit. It is thus longer than in any species of the family known to me.

The frontal foramina are separated by an interspace equal to four-fifths the distance between each and the superciliary border. The pariëto-squamosal suture ascends posteriorly in a nearly straight line to within M. .015 of the posterior zygomatic crest. The posterior squamosal suture then turns directly downwards, reaching the depressed portion of the crest where it bounds the huge mastoid fossa and foramen.

The posterior part of the mandibular ramus, shows a regularly convex angular border commencing just below the condyle. The coronoid process is quite small and the short connecting edge between it and the condyle is not excavated below the level of the latter. The articular face of the condyle is directed upwards, and on the internal third, presents a face posteriorly also. The ramus diminishes rapidly in depth anteriorly. The masseteric fossa does not descend below the level of the second true molar, and is not sharply bordered anywhere. The internal pterygoid fossa on the other hand occupies the entire inner face of the angle between the condyle and the inferior border, and anteriorly to the line of the last inferior molar tooth.

The superior true molars have short crowns, as in Eucrotaphus and Oreodon. The anterior and median vertical ridges are very prominent, and the posterior vertical border of the posterior column projects to a slight

extent posteriorly. Enamel smooth. The last inferior molar is not so disproportionately larger than the second as in *M. leptorhynchus*, *arenarum* and *elegans;* and with the second, has little of a prismatic character. No cingula.

Measurements.	M.
Length from occipital condyle to postglenoid process...	.047
" " " " " postfrontal process. ..	.101
Vertical diameter of orbit	.036
Depth of malar bone at middle of orbit	.012
" " zygomatic process at posterior angle	.024
Width at middle of supraorbital border	.060
" " malar bones	.090
" of occipital condyles	.032
" " occiput at lateral crests	.036
" " " " condyles	.061
Elevation of occiput with condyles	.054
Depth of skull at glenoid surface	.058
" " " " orbit, exclus. malar	.054
" " mandible at condyle	.075
" " " " coronoid	.083
" " " " posterior edge of m. iii	.042
Depth mandible at middle of m. ii	.028
Diameters superior m. ii { anteroposterior	.016
Diameters superior m. ii { transverse	.016
Diameters superior m. iii { anteroposterior	.020
Diameters superior m. iii { transverse	.0155
Diameters inferior m. ii { anteroposterior	.015
Diameters inferior m. ii { transverse	.012
Diameters inferior m. iii { anteroposterior	.0225
Diameters inferior m. iii { transverse	.0115

A second specimen of this species consists of the occipital, pariëtal, and part of the frontal regions, with the right maxillary bone, and fragments of the left maxillary, of the mandible, etc. The latter demonstrates the position of the infraorbital foramen to be above the anterior border of the fourth superior premolar. The middle line of the occiput presents a keel on its superior half. The basioccipital bone between the paroccipital process is expanded laterally, and is without median angle or groove. Between the bullæ it is compressed, and its middle line forms a narrow truncation. Opposite the posterior third of the bulla, this surface ascends at an angle, and gradually widening, spreads into the general flattened convex inferior face of the sphenoid. The anterior part of the sagittal crest is a little better developed than in the typical specimen. The worn teeth indicate an old individual. The canine is large, and the first premolar has its roots well distinguished. The facial plate of the maxillary concave above second premolar. No appreciable diastema.

Measurements.	M.
Length of molar series	.081
" " premolars on bases	.041
Width of canine posteriorly	.010
Diameters P-m. iv { anteroposterior	.010
Diameters P-m. iv { transverse	.012

Of this species I have but two specimens, which were obtained from the Ticholeptus beds of Deep river, Montana, by my assistant, J. C. Isaac.

Merychyus elegans Leidy.

Proceedings Academy Philada., 1858, p. 24. Extinct Mammalia Dakota and Nebraska, 1869, p. 118, Pl. XI, figs. 1–11.

Niobrara river, Nebraska.

Merychyus zygomaticus Cope.

Ticholeptus zygomaticus Cope, American Naturalist, Feb. 1878. Bulletin U. S. Geolog. Survey Territories, 1878, p. 380.

This species is peculiar in having the posterior expansion of its zygomatic arch horizontal instead of vertical. It has a thickened external edge which continues into a strong posterior angle which projects behind the posterior margin of the postglenoid process. The auricular meatus is directed posteriorly in a way quite peculiar, resembling somewhat the position seen in some of the hogs. The malar bone is very prominent. The infraorbital foramen is above the contact of the third and fourth superior premolars. The larmier is large and its maxillary border descends posteriorly.

In size this species is between the *M. elegans* and the *M. medius*. If my identification of New Mexican specimens is correct, this species differs from the *M. medius* in the much less production of the premaxillary region, besides the smaller size.

Ticholeptus beds of Deep river, Montana ; J. C. Isaac.

Merychyus medius Leidy.

Proceedings Academy Philad'a, 1858, p. 25. Extinct Mammalia, Dakota and Nebraska, 1869, p. 119, Pl. XI, figs. 12–14. Cope U. S. Expl. Surv. W. of 100th Mer., G. M. Wheeler, iv, pt. ii, p. 324.

Niobrara river, Nebraska, Hayden ; Santa Fé, New Mexico, Cope.

Merychyus major Leidy.

Proceedings Academy Philada., 1858, p. 26. Extinct Mammalia, Dakota and Nebraska, 1869, p. 121, Pl. X, figs. 15–16.

This species, known hitherto from Leidy's descriptions of four of the superior molars, is the largest of the genus, and perhaps of the family. More information regarding it is much to be desired.

Headwaters of the Niobrara river ; from Loup Fork beds, according to Hayden.

LEPTAUCHENIA Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, 122. Proceedings Academy Philad'a, 1856, 88, (nomen nudum). loc. cit. 1656, 163 (nomen nudum).

As already remarked by Leidy, this genus is characterized by the presence of enormous vacuities of the superior surface of the muzzle. The genus might be described as lacking the usual superior osseous wall of the nasal cavities and maxillary sinuses. The generic diagnosis is as follows:

Otic bullæ inflated. Four premaxillary teeth. Nasal bones excessively contracted, leaving a wide interspace between them and the maxillaries. Symphysis mandibuli coössified.

This genus has but a short range in time, not having been yet found out of the Ticholeptus beds. It shows in its deficient ossification, and smaller size, that this line of the family was approaching its extinction, its decadence having already commenced in the genus Merychyus. The genera which follow in systematic order, Cyclopidius and Pithecestes, exhibit the last steps in the downward course.

I. Infraorbital foramen above P-m. iii.

"Three inferior incisors; nasal sinuses to middle of orbit; true molars .043; skull .135." (Leidy) .... *L. major.*

"Nasal sinuses not extending so far posteriorly as in *L. major;* true molars .032; skull, .101." (Leidy) .... *L. decora.*

"Nasal sinuses reaching to front of orbit; true molars .020; skull .085." (Leidy) .... *L. nitida.*

Leptauchenia major Leidy.

Proceedings Academy Philad'a, 1856, p. 163; 1857, 89. Extinct Mammalia, Dakota and Nebraska, 1869, p. 124, Pl. XII, figs. 1–5.

Tributaries of White river, Nebraska.

Leptauchenia decora Leidy.

Proceedings Academy Philadelphia, 1858, p. 88; 1857, p. 89. Extinct Mammalia of Dakota and Nebraska, 1869, p. 127, Pl. XII, figs. 6–20.

Tributaries of White river, Nebraska.

Leptauchenia nitida Leidy.

Extinct Mammalia of Dakota and Nebraska, 1869, p. 129; Pl. XII, figs. 21–22.

White Earth creek, Dakota, tributary of the White river.

CYCLOPIDIUS Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx* Cope, Ibidem, p. 220.

Dental formula: I. $\frac{0}{2}$; C. $\frac{1}{1}$; P-m. $\frac{4}{4}$; M. $\frac{3}{3}$. Premaxillary bones much reduced; mandibular rami coössified. Otic bulla inflated. Prelachrymal vacuities present, and confluent with enormous nasal vacuities, which are due to the excessive reduction of the nasal bones. Orbit closed behind.

This genus is Leptauchenia without superior incisor teeth, and with but two on each side below. I originally asserted the presence of superior incisor teeth, and it is true that there is in early life a minute tooth in each premaxillary bone, as indicated by the alveoli in a specimen which contains the full deciduous molar dentition. I have not seen the teeth themselves, and it is evident that they are early shed. In an adult specimen of *C. simus* it seems that the alveolar portion of the premaxillary bone has been absorbed.

The meatus auditorius externus occupies a more elevated position in this genus than in any other of the family. It is also directed somewhat posteriorly. There are postpariëtal foramina.

The cerebral hemispheres are not large, and scarcely rise above the plane of the summit of the large cerebellum. Convolutions three on each side, weakly defined.

The concavity of the superior border of the premaxillary bones, together with their upward production, leads me to suspect that the external nares were superior in position. This is the indication of an aquatic habit of life, such as is led by the hippopotamus. Like that animal, the nostrils in Cyclopidius were probably valvular to prevent the ingress of the water. The animals probably passed much of their time in the water, and the nostrils could be brought to the surface for the purpose of respiration, while the remainder of the head and body remained concealed. The prominent rim of the auditory meatus suggests a similar valvular closure of the organ of hearing, and is also a provision for its easy approximation to the surface of the water when necessary.

The milk dentition is like that of Artiodactyla in general. That is, in the superior series the third molar is more elongate and complex than its permanent successor, and the fourth is like the first permanent true molar in constitution. In the inferior series the anterior three teeth resemble the permanent premolars, while the fourth is trilobate.

In the loss of the incisor teeth and the subprismatic molars, we observe in Cyclopidius the same evidences of specialization already known in other types of Ungulates.

I know of but two species of Cyclopidius.

Cyclopidius simus Cope.

Proceedings American Philosophical Society, 1877, p. 221. *Brachymeryx feliceps* Cope, Ibidem, p. 220 (immature).

The specimens of this species in my possession embrace a complete skull with one zygoma and half of the brain-case wanting; a left maxillary bone with all the teeth; and three mandibular rami with dentition, all of adults. Of immature individuals, I have two muzzles with dentition of both sides, and six mandibular rami; in all, parts of thirteen individuals. The following description of the skull is taken from the specimen first named, which is the type of the species.

The cranium is wide and depressed, and the muzzle is short. The pro-

file descends at the orbits into the nasal vacuities, which cause a deep excavation of the facial plate of the maxillary region. The small nasal bones form a promontory below the level of the orbits, whose superior borders are convex. The maxillary bones rise at the end of the muzzle, forming, probably, with the confluent premaxillaries, a subquadrate projection. The superior side of this process is concave on its interior aspect forming a curved suture of an expanded nasal bone. Its anterior edge is also concave on their inner side, as though adapted to a forward-looking nareal opening. This anterior border is produced downwards into a free conical process which bounds the canine alveolus in front. This I suppose is all that there is of the alveolar portion of the premaxillary bone. The corresponding part of the other side is lost. There is a well-marked preorbital fossa. Its supero-interior border bounds the huge nasal vacuity on each side. The nasal bones form a narrow promontory, with convex superior face, which extends a little beyond a line connecting the middles of the preorbital fossæ. The vacuities excavate the frontal bones as far back as a line connecting the middles of the supraorbital borders. The frontal bone is thus of a Λ-shape. The anterior temporal ridges are well defined, but do not reach the free edge of the frontal bone. Their union into the sagittal crest is gradual. The brain-case is moderately elongate, the postorbital process of the malar bone marking the middle of the total length. In profile the posterior part of the skull is nearly straight. The sagittal crest is gently convex, and is not so deeply bifurcated posteriorly as in most other forms. The posterior temporal crests are expanded laterally, and continue well developed to above the meatus auditorius, into the superior edge of the zygoma. They are not continued downwards on the occiput, as in most of the other genera of the family, but resemble the species of Merychyus more than any others in this respect. The temporal fossa has a wide floor, due to the lateral extension of the meatus auditorius, and the glenoid portion of the squamosal. The superior edge of the zygomatic process of the squamosal is little elevated, and is regularly convex. The process is not produced as far anteriorly as the posterior border of the orbit. The malar bone is remarkable for its depth, exceeding in this respect any species of the family yet known. Its external face slopes obliquely outwards below, but not very much, and is slightly and uniformly convex. Its inferior edge is thickened and descends anteriorly, and then thins and rises continuously to the zygomatic process of the squamosal.

The occipital aspect of the skull is wide and low. Its superior region is slightly convex and roughened on each side of the median line. From and below this valley, the middle line presents a sharp carina, which disappears in a narrow convexity above the foramen magnum. Between this convexity and the meatus auditorius, the surface is concave. The occipital condyle is small, and the exterior half is more extensive than the posterior half. The paroccipital process is large. Its base diverges from the occipital condyle, and is adherent by its anterior face to the otic bulla,

without intervening ridge. The posttympanic mass is broken away. It is inferior in position to the auricular meatus. The latter, being directed posteriorly, is considerably produced behind the postglenoid process, leaving a wide postglenoid fossa. The postglenoid process is rather small, and its posterior face is entirely covered by the tympanic bone, while its interior edge is in close contact with the otic bulla. The bulla is of enormous size, and is a slightly compressed oval placed anteroposteriorly. It fills the entire space between the postglenoid process and the basicranial axis, and reaches anteriorly almost to the line of the anterior border of the glenoid region. The pterygoid process adheres to its internal wall for half its length, and it sends forwards on the external side of the pterygoid, a narrow acuminate apex. The internal extremity of the glenoid cavity is concave, and the surface descends, forming a robust peduncle, as large as the postglenoid process, to which the anterior part of the otic bulla is attached. This is a character I have not seen in any other species of the family. A wide surface, continuous with that of the glenoid face, extends on the external side of the pterygoid ala of the sphenoid, to the angle where it unites with the pyramidal process of the palatine. It there terminates abruptly, but the external angle marks the end of a ridge, which extends upwards and forwards to the postorbital process of the frontal. Anterior to this line the cranial wall is concave ; posterior to it, convex. The processi pyramidales are divergent, and have thickened and rounded inferior edges. The maxillary bones are produced a little beyond their bases, leaving a notch between. The palatal surface is uniformly moderately concave.

The incisive foramina are large ; the septa are wanting in my specimens, perhaps accidentally. The infraorbital foramen is above the middle of the fourth premolar tooth. The frontal foramina are further apart than in any other species of the family, being equidistant between the median line and the supraorbital border. There is an internal orbital foramen below the postorbital process, as in other species of the family. There are three postpariëtal foramina, two of which are on the squamosal suture. Below the anterior of these two is a large postsquamosal foramen. No supra or postglenoid foramina. The meatus auditorius externus looks equally externally and posteriorly. It is large and of oval outline, the long diameter being parallel to the superior border, which is the usual suprameatal crest. Its tympanic or anterior border is very prominent, while the posterior border is a little less so. A posttympanic tuberosity marks the middle of the inferior edge. Posterior to the meatus is the rather large mastoid foramen, which is above the internal base of the paroccipital process. The basicranial bones being lost, the characters of the basal foramina are not determinable. The posterior nares are deeper than wide. The palatonareal border is a Gothic arch, of which the apex is opposite the posterior border of the last molar tooth. I perceive no palatal foramina.

The median and posterior nasal sutures remain. The latter is a V with

the apex opposite to the frontal foramina. Lambdoidal suture confluent. The malosquamosal suture marks the posterior edge of the posterior orbital rim at the middle of the orbit. The pariëto-squamosal suture has an inferior position in front. Opposite the front of the postglenoid process it converges inwards in line for the occipital bifurcation, and is continued as the pariëtoöccipital suture, nearly to that point. The squamosal border, however, extends in a Z-form to the posterior temporal crest half-way between the bifurcation and the meatus auditorius. It embraces an area of the posterior face of the skull, and the posterior half of the rim of the auricular meatus.

The typical specimen presents only the alveoli of the canine and first premolar teeth; otherwise the dentition is perfect. The crowns of the second and third premolars are obliquely quadrate in horizontal section, both a little wider posteriorly than anteriorly. This is due to the presence of a half crescent of the internal side, whose posterior horn is attached to the external wall, while the anterior is free. The external faces of these premolars is slightly convex; of the fourth premolar is slightly concave. The first true molar is decidedly smaller than the second, and the second is smaller than the third. The external sides of the external columns are flat in the first true molar, but become more concave on the third. The anterior edges of the columns project, forming ridges; or in section, projecting angles. No intermediate ridges, nor cingula. The third superior true molar has a prismatic crown, no roots being visible in either of the adult specimens, of which the typical one is rather old, as indicated by the wear of the teeth. In the latter specimen the roots of the second true molar are apparent, although the crown is elevated. The first true molar is not prismatic, although the crown is not low. The specimen represented by the left maxillary bone contains the teeth which are wanting from the typical one. The section of the crown of the canine is a semicircle, the truncate face being posterior internal. It is not a large tooth, and is separated from the first premolar by a diastema equal to its diameter. The first premolar is one-rooted, the root with a groove on the internal side. The section of the base of the crown is a triangle, the faces being anterior, external, and posteroïnternal. Its inner face is concave above the base.

None of the separate mandibular rami are complete, all lacking the angle and condyle. The former is full and round, judging from a fragment in my possession. The ramus diminishes regularly in depth forwards. The symphyseal region is short, and its anterior face is very steep, except at the alveolar region, where it is everted forwards. No trace of suture. The internal pterygoid fossa is large and strongly marked, so that the inferior edge of the ramus is inverted, so that the surface is convex externally. The last molar is placed somewhat obliquely. The first and second premolars are directed outwards and forwards, and the incisors directed forwards.

There are two incisors on each side of the symphyseal line. They are very small and subcylindrical, and are closely packed between the canines.

The canines are much larger, with cylindric root and flat, incisor-like crown. The first premolar is still larger, and is of about the same form as the canine, from which it is only separated by a slight divergence of the crowns. There are no diastemata. The second premolar has a compressed triangular crown, with a median ridge on the internal side. Its long diameter is diagonal, running outwards posteriorly. The long axis of the third premolar is similar, while the other teeth are more nearly in line. In the third premolar the fossa interior to the median internal heel is much deeper than that posterior to it. The corresponding fossa is still larger in the fourth premolar, while the crown has a heel in the form of a transverse curved crest, separated from the median heel on the inner side by a fissure. The true molars increase rapidly in size posteriorly, but not so abruptly as in the *Pithecistes brevifacies*. The internal crescents are very flat, and the posterior edges of their columns project moderately. The external crescents are very convex. The prismatic character of the teeth increases much posteriorly, so that the roots of the third tooth are short, and the crown long. The enamel is minutely rugose.

The third superior temporary molar has two pairs of crescents. The anterior pair are, however, not so well developed as the posterior pair and the two valleys are soon obliterated by wear. The crescents are equal in the fourth temporary molar. The fourth permanent premolar is protruded at least as soon as the third true molar, sooner than the posterior column of the latter. In this it differs from the *Oreodon culbertsoni*, where the last true molar is protruded first, and is a cotemporary of both the third and fourth deciduous molars ;* and the *O. gracilis*, where the last true molar is a cotemporary of the third deciduous.

In the inferior temporary dentition, the lobes of the last molar are subequal, the posterior one being a little the larger. The protrusion of the last true molar is also probably delayed until the shedding of the deciduous series, as in the superior series ; but my specimens are either very young or fully adult, and therefore I cannot demonstrate this point as fully as in the case of the superior series.

Measurements of Skull.

	M.
Length from condyle to front of canine inclusive	.117
" " " " otic bulla (axial)	.010
" " " " palatonareal notch,	.0575
" " " " anterior line of glenoid cavity.	.038
Depth of occiput, including condyle	.041
" at middle of orbit, exclusive of teeth	.037
" " infraorbital foramen " "	.016
" " premaxillary border " "	.023
Width at " " above	.022
" between orbits	.038

*Leidy. Ancient Fauna of Nebraska, 1853, p. 51, Pl. IV, figs. 1, 2.

Measurements of Skull.		M.
Width at malars below orbits		.086
" " zygomata at middle		.092
" " auricular meatus		.070
" of occipital condyles		.0275
" at middle of last molars inclusive		.049
" " " second premolars inclusive		.030
Diameters otic bulla	anteroposterior	.023
	transverse	.018
	vertical	.019
Diameters of nasal bones	length of fragment of	.024
	width at base	.0125
Length of dental series		.062
" " premolar series		.025
" " true molar		.033
Diameters P-m. iii	anteroposterior	.007
	transverse	.0065
Diameters m. i	anteroposterior	.0085
	transverse	.0085
Diameters m. iii.	antereposterior	.0146
	transverse (greatest)	.011
Depth of mandibular ramus at m. iii		.031
" " " " P-m. iv		.019
Length of symphysis		.0245
" " premolar series		.022
" " true molar		.035
" " of total dental series		.063
Diameters P-m. iv	anteroposterior	.0085
	transverse	.006
Diameters m. i	anteroposterior	.009
	transverse	.0068
Diameters m. iii	anteroposterior	.016
	transverse	.0062

The second specimen with permanent dentition is of smaller size than the type, and the canine teeth are small. It may have been a female. The dental series, including the canine, measures M. 0.59 ; the premolar series, 0.23 ; the true molars, 0.31.

The number of specimens of this animal found in the restricted area of the Ticholeptus bed of Deep river, Montana, shows the former abundance of the species. It was probably gregarious, in the manner of the other Oreodontidæ. We can depict it as seeking the swamps of the shore for its vegetable food, and spending much of its time in the water when not feeding. It was doubtless a good swimmer, and the characters of its feet will be sought for with interest for light on this point. The use of the huge superior nasal vacuity of the skull of this genus and Leptauchenia can

only be guessed. Perhaps it supported an inflatable bladder like that of the crested seal, or a swollen muzzle like that of the saiga antelope.

Cyclopidius emydinus, sp. nov.

This species is represented in my collection by a nearly perfect cranium. It indicates an animal of about the same size as the *C. simus*. The differences between the two species may be enumerated in advance of the detailed description. Firstly, the external vertical ridges or crests of the true molars are directed obliquely forwards so as to overlap the external wall of the anterior crescent much more extensively than in *C. simus*. (2) The crowns of the true molars have a relatively greater transverse diameter. (3) There is a peculiar process at the external base of the otic bulla, between the paroccipital and postglenoid processes, which may be called the subtympanic process. (4) There is no median occipital keel. (5) The maxillary bone is prolonged posterior to the last superior molar, which it is not in *C. simus*. (6) The oblique orbitosphenoid ridge is wanting. (7) The otic bullæ are shorter and wider in their form. This character will require confirmation by examination of many individuals.

The skull is singularly depressed and expanded laterally, so as to present an outline not unlike that of some river turtles. The orbits are in the anterior half, and look forwards and upwards, as well as outwards. The muzzle is short, so that its lateral borders approximate rapidly to a narrow truncate extremity. The maxillary borders do not contract quite so abruptly, and are visible outside of the canthus rostralis, when the skull is viewed from above. The brain-case is depressed, and is expanded posteriorly, and narrowed at the anterior line of the zygomatic foramina. The posterior temporal ridges are much expanded, forming a wide rim round the brain-case posteriorly, which is continued into the squamosal processes of the zygoma on each side. The anterior temporal ridges approach each other very gradually on the middle line, and only reach the union into a sagittal crest a centimeter posterior to the frontoparietal suture. The edge of the crest is truncate, and it is not bifurcate posteriorly, as in most Oreodontidæ.

The occiput is broad and low, and differs in character from that of most other members of the family. Its posterior face is flat, only interrupted by a fossa on each side, just within the posterior edge of the meatus auditorius externus. This edge is continued downwards into the external border of a distinct mastoid process, which is also the external border of the occiput, deflected a little forwards. The paroccipital process is flat at the base, and is applied to the external half of the otic bulla. Its free extremity is subround. The mastoid process forms a prominent ala of its external side, having a transverse width equal to that of the base of the paroccipital. Its inferior edge is truncate obliquely outwards and downwards to a subacute angle. The occipital condyles are relatively small.

The external meatus of the ear looks outwards and backwards at an angle of 45° to the middle line. The prominent edge of the mastoid pro-

cess is directly below its anterior border. Thus the tympanic bone is directed obliquely downwards and forwards. Posteriorly it is separated by a groove from the mastoid process. Anteriorly it is separated by a fossa from an osseous mass which occupies the space between it and the post-glenoid process. Before the skull was reconstructed from its fragments, this mass was observed to be entirely distinct from the postglenoid process, which it equals in height. Continuous with it, there descends another osseous body to near the line of the extremity of the mastoid process, with a truncate inferior edge, which is separated from the otic bulla by an open groove. The stylohyal ligament is probably inserted into a fossa at the anterior extremity of this groove. The postglenoid process is low and more extended transversely. The anteroposterior diameter is small. The glenoid surface is much extended transversely and terminates externally in a slight thickening. The zygomatic process of the squamosal bone is at first expanded horizontally and has a low convexity of the thin superior edge. Its vertically compressed portion is entirely supported by the malar, and does not extend so far forwards as the anterior edge of the zygomatic foramen. The malar bone is remarkable for the depth of its suborbital portion, which fully equals the diameter of the orbit. Its inferior edge presents a thickened angle downwards below the anterior part of the last superior molar. Its superoanterior angle terminates in a prominent rib of the side of the face, which extends along the inferior edge of the facial vacuity. Beneath the anterior part of the latter the face is concave. Above this concavity the ascending plate of the maxillary is convex in the vertical section, turning inwards at the apex to unite with the lateral part of the extremity of the nasal bone. The preorbital fossa is small and looks forwards and upwards.

The otic bullæ are larger than in any other Oreodontid. They are of a short oval form, somewhat truncate anteriorly and posteriorly. Thus they differ from those of *C. simus*, where they are elongate-oval. They only reach as far anteriorly as the middle of the internal extremity of the glenoid surface; while in *C. simus* they reach the line of the posterior outline of the zygomatic foramen. They terminate near the inferior internal point, in a little acute osseous apex, which is smaller than in *C. simus*. The bullæ approach so closely together that the bassioccipital is much narrowed, and the sides of its inferior surface are excavated so as to reduce the middle line to a narrow acute keel. The lateral excavations follow the posterior internal base of the bullæ, leaving a median table, which is itself excavated by a shallow fossa, which extends from the median keel to the foramen magnum. The median keel disappears anteriorly. The sphenoid is protuberant downwards as a narrow convex rib, which rises and disappears in the presphenoid. The descending sphenoid ala forms the posterior boundary of the posterior nareal trough, and makes a strong angle with the pyramidal process of the palatine, which is turned outwards. The pterygoid squama terminates in an apex which points downwards and posteriorly towards the apex of the otic bulla. The palatonareal border is

V-shaped, and is in line with the posterior edge of the maxillary bone. The latter projects beyond the last molar tooth as far as the anteroposterior diameter of the latter. It has no projection in the *C. simus.* There is no notch between the maxillary bone and the processes pyramidalis of the palatine. The palate is of nearly equal width from the last molar to the third premolar; its roof is gently concave posteriorly; nearly flat anteriorly.

The premaxillary bone is a narrow strip which rises nearly vertically from its short alveolar border, and is curved outwards above in agreement with the expansion of the anterior edge of the maxillary, to which it is united by simple suture. The nasal bones are of remarkable form. Together they enter the anterior part of the frontals in a V-shape, and extend forwards in a narrow shaft. Opposite the anterior borders of the orbits the shaft begins to widen gradually, and the surface to flatten, until they reach the posterior angle of the ascending part of the maxillary. Each one then expands outwards, terminating in a semi-disc which fits the concavity of the superior edge of the maxillary above mentioned. The entire shape of the nasal bones is that of a spade with a triangular apex to the handle, and the short blade at the opposite (anterior) extremity. The frontal bone is V-shaped, the angle posteriorly directed, and engaged between the pariëtal bones, and each branch terminating above each orbit. Narrow prolongations extend anterior and posterior to the orbit, joining the lachrymal and malar bones respectively. Its median suture is, like that of the nasal bones, well defined. The alisphenoid and pariëtal have extensive connection. The pariëtosquamosal suture is horizontal in front; it then gradually rises. It is not associated with a ridge as in some other species. The occipital forms the posterior five millimeters of the sagittal crest.

The nasal opening is subtriangular, with the base above, and is directed anteriorly. The facial vacuities are enormous, and excavate the frontals to a point which make the anterior third of the orbit's diameter. They are only separated on the median line by the very narrow isthmus of the nasal bones. The infraorbital foramen is above the anterior part of the fourth surperior true molar. The frontal foramina are small, and are not symmetrical. That of the left side is half-way between the median suture and the superciliary border; the other is nearer the superciliary border. No supraglenoid foramen. Postsquamosal present; that part of the cranial walls is injured. The anteroposterior diameter of the orbit exceeds the vertical. The auricular meatus is the largest known in the family, and it has a prominent border and regularly oval outline. Its long diameter rises posteriorly from the horizontal. It is more laterally and less posteriorly directed than on the typical and only skull of *C. simus.* The foramen magnum has an openly angulate superior border. Jugular, condyloid, and carotid foramina not obvious, owing to the close contact of the otic bulla with surrounding bones. *Foramen ovale* larger than the *F. lacerum anterius,* and external to it in position. *F. rotundum* still larger, inferior in position, bounded on the external side by a

tuberous projection of the angle from the anterior edge of the glenoid surface. There is a deep fossa at the internal base of the postglenoid process, which possibly enters a foramen. No postglenoid foramen.

Although the skull of the *Cyclopidius emydinus* is more robust than that of *C. simus*; the length of the tooth-line is the same. The incisive edge of the premaxillary bone displays one empty alveolus, from which the single incisor was easily shed. The canine is not large, and the base of the crown has a regularly convex anteroexternal face; apex lost. The diastema posterior to it is equal to its diameter. The crowns of the premolars are worn; they are of about the size and proportions of the *C. simus*. The true molars differ, as I have already pointed out, in their greater transverse diameter, and the greater anterior prolongation of the anterior horns of the posterior external crescents. The deep notch which is enclosed between this fold and the wall of the crescent in front of it is filled with cementum. As to the form of the true molars, the transverse diameter of the first considerably exceeds its anteroposterior diameter; in the *C. simus* the former diameter is equal to the latter. In *C. emydinus* the last true molar is as wide as its length without the heel; in the *C. simus*, the transverse diameter is much less. In *C. simus* the heel is more prominent, and is recurved into a vertical ridge, which is wanting in the *C. emydinus*. In *C. emydinus* this tooth shows but little of the prismatic character, as the roots are of usual length.

The lower jaw of this species is not yet known.

Measurements.

	M.
Length of skull along base	.129
Length from condyles to posterior edge of zygomatic foramen	.042
Length from condyles to palatonareal foramen	.063
" " " " line of last true molar	.071
" " occipital crests to line of orbits	.074
" " " " " facial vacuities	.084
" " " " " ascending process of maxillary bones	.115
Length from occipital crest to free end of nasal bones	.126
Elevation occiput, including condyles	.045
" of front at middle of orbit, without molars	.035
" " maxillary bone at P-m. iii	.015
" " " " " P-m. i	.025
Width of skull at occipital condyles	.0675
" " " " superior edge of meatus auditorius	.057
" " " " middle of zygomatic foramina	.092
" " brain-case at middle of zygomatic foramina	.029
" " skull at orbits	.083
" " ,, between orbits	.047
" " muzzle at superior edge of nares	.0215

Measurements.		M.
Diameter external nares	vertical	.014
	transverse above	.017
Diameter of a facial vacuity	anteroposterior	.030
	tranverse	.013
Diameter of orbit	anteroposterior	.023
	vertical	.019
Diameter of zygomatic foramen	anteroposterior	.053
	transverse	.026
Diameter of foramen magnum	vertical	.0095
	transverse	.013
Diameter of meatus auditorius	vertical	.009
	anteroposterior	.011
Diameter of otic bulla	vertical	.025
	anteroposterior	.025
	transverse	.022
Width between canine teeth		.008
" " last true molars		.0285
Length of dental series		.065
" true molar series		.0343
" premolar		.0254
Diameters P-m. ii	anteroposterior	.0056
	transverse	.0050
Diameters P-m. iv	anteroposterior	.0070
	transverse	.0080
Diameters m. i	anteroposterior	.0075
	transverse	.0110
Diameters m. iii	anteroposterior	.017
	transverse (with external rib)	.012

The only specimen of this remarkable species known to me was found in the valley of Deep river, Montana, by my assistant, Mr. J. C. Isaac. The wear of the true molars shows that the animal was of full age, though not old.

PITHECISTES Cope.

Proceedings American Philosophical Society, 1877, p. 219.

This genus represents the final term in the decadence of the once powerful and numerous family of the Oreodontidæ. It is unfortunately established on a mandibular ramus only, and although some maxillary bones are referred to it with much probability, they are not preserved in such a way as to demonstrate the presence of the large nasal sinuses characteristic of Leptauchenia. I, however, suspect that they occur. The genus further resembles Leptauchenia in the coössification of the mandibular rami, and the reduction in number of the incisor teeth. In *P. brevifacies* there is but one inferior incisor tooth on each side. As reduction in the superior incisors usually precedes reduction in

those of the lower jaw, I suspect that the former were absolutely wanting in this genus. If so, we have in the Oreodont line the same process of reduction above, as has taken place in other lines of Artiodactyla at the latest or modern stage of their history.

In Pithecistes the inferior canine is caniniform, and masticated in contact with the superior canine, owing to the great abbreviation of the symphyseal region.

The diagnosis of the genus is as follows :

Inferior premolars three ; incisors one. Canine caniniform, masticating with the superior canine. No diastema. Symphysis coössified.

Two species are referred to this genus without conclusive evidence as to the number of their premolars. It is probable that they have but three, since their superior fourth premolars are of reduced size and incomplete type of form.

Pithecistes brevifacies Cope.

Proceedings American Philosophical Society, 1877, p. 219.

Ticholeptus beds of Deep river, Montana. Discovered by J. C. Isaac.

Pithecistes decedens Cope, sp. nov.

Established on a right maxillary bone, which contains the fourth premolar, the first and second true molars, and part of the alveolus of the third true molar. The last named tooth was not probably entirely protruded. This, with the moderate wear of the fourth premolar, indicates that the animal was fully grown, though young.

The species differs from all the members of the family whose dentition is known to me in the small size and simplicity of structure of the fourth premolar. The internal crescent of this tooth bounds only the posterior three-fourths of the external wall, and therefore leaves the anterior edge of the latter free. It is, moreover, not very convex, and its edge is not so elevated as is that of the external wall. The latter is flat on the external side, and its anterior marginal angle corresponds with the point of junction of the anterior extremity of the internal crescent. The true molars have the anterior horns of their crescents prominent, being sections of well-developed vertical columns. In this they differ from those of the *P. heterodon*, where these ridges are very weak.

The malar process of the maxillary bone is robust and prominent, and begins to expand opposite the first true molar. It presents a tuberosity downwards. The infraorbital foramen issues above the front part of the fourth premolar.

Measurements.		M.
Diameters P m. iv	anteroposterior	.006
	transverse	.005
Diameter m. i	anteroposterior	.0087
	transverse	.0077
Diameters m. ii	anteroposterior	.0115
	transverse	.008

Ticholeptus beds, Deep river, Montana. J. C. Isaac.

Pithecistes heterodon Cope.

Cyclopidius heterodon Cope, Proceeds. American Philos. Society, 1877, p. 22.

In this species the fourth premolar has the same form as in *P. decedens*, but the first true molar differs much in the more prismatic shape, and the absence of the external vertical ribs. It is quite possible that it does not belong to this genus.

Ticholeptus beds of Deep river, Montana. J. C. Isaac.

AGRIOCHŒRUS Leidy.

Proceedings Academy, Philadelphia, 1850, p. 121. Extinct Mammals Dakota and Nebraska, 1869, p. 131 (as family *Agriochœridæ*).

Orbit not closed behind. Fourth superior premolar with two external Vs. Fourth inferior premolar like true molars. Otic bulla inflated. Premaxillary bones distinct; no vacuities in the facial bones.

This genus commences cotemporaneously with the genus Oreodon, and persists longer, viz.: to the close of the John Day epoch. It represents a distinct line of succession from that which we have been considering, and one which contains but two known terms. Next to Agriochœrus comes, in this line, the genus Coloreodon Cope, which outlasted its predecessor so far as is yet known. It commenced with it in the John Day epoch, and continuing into the North Fork beds, which are of later age, did not appear later. This series Leidy regarded as a family distinct from the Oreodontidæ. For the present I prefer the view of Gill, that it constitutes a subfamily, the Agriochœrinæ.

This genus presents us with one of the very few cases in the suborder Artiodactyla, in which the last premolar approaches (above) or accomplishes (below) identity of structure with the true molars. This degree of complication was attained at the same period by both the equine and rhinocerontic lines of Perissodactyla, and all existing members of that order exhibit it. In the Agriochœridæ it made a beginning, but soon disappeared from the earth, and no Artiodactyle has developed such permanent premolars successfully since.

In the characters of the skull this genus is less robust than the Oreodontidæ; but the general skeleton remains unknown.

Five species have been described which are referable to this genus, and two others are now added. One of the former is without premaxillary or superior incisor teeth, and I therefore regarded it as representing a distinct genus under the name of *Merycopater*. It, however, appears that no specimens exist in our museums which exhibit this part of the skull in other species of the genus, so it is absolutely uncertain whether Agriochœrus possesses those teeth or not. The species may then be distinguished as follows:

I. Otic bullæ compressed, base anteroposteriorly ovoid.

a. Foramen infraorbitale above junction of P-m. iii and iv.

Front narrower; internal wall of fourth premolar not complete...*A. antiquus.*
Front wider; skull shorter and higher; internal wall of inferior P-m. iv complete...*A. latifrons.*
aa. Foramen infraorbitale above junction of P-m. ii and iii.
Front medially concave, laterally descending to orbits; sagittal crest short...*A. trifrons.*
II. Otic bullæ mammiform with triangular base.
Front convex; nasal bones acute posteriorly; fourth inferior premolar complete; infraorbital foramen above junction of P-m. iii and iv...*A. guyotianus.*
III. Otic bullæ oblong, constricted at the middle.
Infraorbital foramen above junction of P-ms. ii and iii; front plane; nasal bones truncate posteriorly; postglenoid process robust...*A. ryderanus.*

Besides the above, Leidy has described an *A. major** as near to the *A. antiquus*, but of larger size. Marsh has described a small species from the Uinta formation under the name of *A. pumilus.*† Lydekker figures and describes a superior molar tooth from India as probably belonging to this genus.‡ It is stated by him to have been found in the earlier pliocene formation. If this determination be correct, it represents the latest known species, as the *A. pumilus* of Marsh is the earliest. Owing to incompleteness in the descriptions of these species I cannot include them in the above synoptic table.

Agriochœrus antiquus Leidy.

Proceedings Academy Philadelphia, 1850, 121; 1853, 392; 1854, 157; 1857, 89. Ancient fauna of Nebraska, 1853, p. 24, Pl. I, figs. 5–10. Bronn Lethæa Geognostica, 1856, 933; Leidy Extinct Mammalia Dakota and Nebraska, 1869, 132, Pl. XIII, fig. 4.

White River epoch of Nebraska and Dakota.

Agriochœrus major Leidy.

Proceedings Academy Philadelphia, 1856, p. 164; 1857, 89. ?*Eucrotaphus auritus* Leidy, Owen's Report Geological Survey, 1852, p. 563, Pl. XV, figs. 1–3. Ancient Fauna of Nebraska, 1853, p. 56; Pl. VII, figs. 1–3. Bronn Lethæa Geognostica, 1856, 931.

White River formation of Dakota and Nebraska.

Agriochœrus latifrons Leidy.

Proceedings Academy Philadelphia, 1867, p. 32. Extinct Mamm. Dakota, Nebraska, 1869, p. 135, Pl. XIII, figs. 1–3.

White River epoch of Dakota and Nebraska.

*Extinct Mammalia of Dakota and Nebraska, p. 134.
† Amer. Journal Science and Arts, 1875, p. 250.
‡ Paleontologica Indica.

Agriochœrus trifrons sp. nov.

This species is known to me by a single cranium of an immature individual. It lacks of perfection only the basioccipital, the pterygoid, and the alveolar border of the premaxillary bones. It retains the third and fourth deciduous premolars, while the third true molar is still in its alveolus, where it is exposed in place.

Although the specimen is immature, its characters will not permit me to place it with any other species known to me. I have specimens of like age of the *A. guyotianus*, and these are quite different. From *A. ryderanus* it differs in the form of its otic bulla, etc.

The muzzle and front form a flat horizontal profile, while the pariëtal region is convex. The profile descends gently to the supraoccipital border, or inion. The muzzle is compressed above and below the canine alveolus, and there is a concavity above the third and fourth premolars, and behind the foramen infraorbitale above this fossa the lachrymal region is convex. The nasal bones are lost, so that the form of their posterior suture cannot be ascertained. The frontal bones are gently concave in transverse section between two lines produced forwards from the anterior extremities of the temporal ridges, that is at the postorbital constriction of the cranium. These lines are represented by a rounded longitudinal angle, from which the frontal bone descends to the superciliary border on each side. A trace of this form is seen the *A. ryderanus*. The supraorbital borders diverge outwards and backwards to the postorbital processes. These are prominent horizontally, and are abruptly decurved at the apex. The temporal ridges enclose an urceolate area, having a gentle convexity in their direction before they unite at a point more posterior than in the other species, that is above a line connecting the anterior borders of the postglenoid processes.

The malar bone is slightly concave on the external face, and is moderately deep, and not thick. The squamosal part of the zygoma is rather slender, and does not rise above the postglenoid process. Its superior edge continues without interruption into the posterior temporal crests, and so into the supraoccipital. The postglenoid process is like that of *A. guyotianus*, narrow and produced downwards. Paroccipital lost. The otic bulla is large, its anterior edge extending anterior to the postglenoid process. It is nearly twice as large as in *M. guyotianus*, and extends much further forwards. It presents two flat sides, one external, the other outwards and forwards, and a convex side inwards and backwards. These sides meet at an angular edge below, which runs outwards and backwards. The sphenoid bone is convex between the bullæ. Basioccipital lost. The palatonareal border is convex, and is opposite the middle of the second true molar. In the mature skull it would be probably more posterior. The palate is everywhere concave in transverse section.

The frontopariëtal suture is broadly convex, and is opposite the anterior edge of the glenoid surface, and 25 mm. in advance of the sagittal crest. The anterior processes of the bone on each side of the nasals are wide and truncate, and do not extend beyond the interior suture of the lachrymal

bone. The latter is about as long on its superior sutures as it is deep at the orbit. It presents a distinct preorbital angle above a prominent tubercle. The occipito-pariëtal suture extends well forwards, 30 mm. in advance of the crest. The squamosal does not reach to the lateral occipital crest.

The infraorbital foramen occupies the position it has in the *A. ryderanus*. In a young specimen of *A. guyotianus* it has the same position as in the adult. The frontal foramina are about as far apart as each is from the supraorbital border. There is a postpariëtal foramen on the pariëto squamosal suture, and there are three postsquamosals, two of them near together, and near the posterior suture, the other below the postpariëtal foramen. *Foramen ovale* oval, about as large as the *F. rotundum*, and separated from the foramen lacerum by the produced base of the inferior ala of the sphenoid bone. Palatine foramen opposite the third deciduous premolar.

Superior canine teeth robust, bases of crown one-half lenticular, the posterior face truncate. A considerable diastema anterior to first premolar, and a short one behind it. Other teeth in continuous series. First and second premolars two-rooted ; absolutely simple. Third and fourth crown of first of usual form. First true molar smaller than second. Enamel minutely roughened.

Measurements.	M.
Length from supraoccipital crest to canine inclusive	.180
" " " " " front of bulla	.036
" " " " " penultimate molar	.108
" " " " " orbit (axial)	.105
" " " " " front of orbit	.126
" of sagittal crest	.046
" " superior molars (last included)	.076
" " premolars	.036
Diameters M. i { anteroposterior	.063
{ transverse	.014
Diameters M. ii { anteroposterior	.0165
{ transverse	.020
Width of skull at postglenoid inclusive	.077
" " " middle of zygomas	.050
" " " fundus of canine alveolus	.038
" between canines	.020
" " second true molars	.033
" of skull at postfrontal processes	.076
" " " between anterior rims of orbits	.066

The label from this specimen is lost. It is, however, from Oregon, and to judge from the color, from the true John Day epoch, rather than the North Fork bed.

Agriochœrus guyotianus Cope.

Hyopotamus guyotianus Cope, Proceedings American Philosophical Society, 1878, p. 77. *Merycopater guyotianus* Cope, American Naturalist, 1879, p. 197, Proceeds. Amer. Philos. Soc., 1879, 375.

Three crania, one with nearly entire mandible, and numerous fragments with mandibles, represent this species in my collection. It is the most abundant species of this genus in the John Day beds of Oregon.

The cranium is of peculiar form. It is elongate from the orbits backwards. The muzzle is elevated and compressed, so that the profile is horizontal, with subordinate irregularities. The occiput is therefore low as compared with the muzzle. The zygomata are rather slender, and are not expanded. The side of the muzzle is concave just below the superior border of the maxillary bone and above the fundus of the canine alveolus. The inferior part of the maxillary is concave from below the anterior border of the orbit to the line of the canine alveolus. The region above and anterior to the lachrymal bone is convex, leaving the flat nasal bones a little depressed. The frontal has a convex swelling on the middle line just posterior to the frontal foramina, from which point the surface slopes gradually and evenly to the supraorbital borders, and not in two planes, as in *A. trifrons.* At the front of the orbit the section of the frontal bone is convex at the sides and a little so at the middle. The supraorbital border is short and concave, not long and straight as in *A. trifrons,* and the postfrontal process is moderately prominent, and is not decurved. The anterior temporal ridges do not reach them. The former converge in nearly straight lines at an acute angle to a long sagittal crest. This in turn bifurcates into two very prominent posterior temporal crests, which overhang the occipital condyles. The brain-case is an elongate-oval, and the olfactory portion is long and narrow, but not especially constricted at any one point. There is a prominent small tuberosity at the inferior part of the lachrymal bone ; above it the preorbital border is not defined as far as the beginning of the supraorbital. The postfrontal process originates below the anterior temporal surface which is continued along its posterior edge. The malar bone is concave on its external face. The zygoma is compressed, and has a long low superior convexity behind. Its crest continues into a fine, low, posttemporal crest, which turns posteriorly above to its prominent posterior expansion above mentioned. The latter turn outwards at the apices, and send a low ridge downwards towards the occipital condyle. Below, the latter form a low angle on each side, which separates a median from a lateral plane. Above, the occiput is deeply concave, and has a trace only of median keel.

The basicranial axis is flat and rather wide between the otic bullæ. The occipital condyles have distinct inferior boundaries which are separated by a flat interval. The posttympanic region is wide, and is bounded inferiorly by the deep styloid fossa. This is surrounded internally and posteriorly by the funnel-shaped base of the paroccipital process, which extends first posteriorly as a longitudinal lamina, and then outwardly. Its

edge terminates in a rough band which curves upwards and backwards to a point above the line of the occipital condyle. It is separated by a shallow groove from the corresponding posttympanic ridge. The tympanic bone is not so long as in the species of Oreodontinæ, and presents a tuberosity externally. Like the paroccipital its base unites with the otic bulla. The bulla is small. Its base is extended towards the postglenoid process, but it is well separated from it, and does not reach the line of its anterior border. It presents a face anteriorly, and one inwards. The postglenoid process is narrow transversely, the depth and width being equal, and is elongate downwards.

The coronoid process of the mandible is short, but has a base extended anteroposteriorly. The articular face of the condyle is convex anteroposteriorly, and is extended downwards on the inner side behind. The horizontal ramus is slender, and has a straight inferior border. (The angle is broken away from this specimen.) The symphysis is oblique and nearly straight in profile. It is moderately elongate, and has the suture persistent. There is a tuberosity looking downwards from its posterior extremity, where it is rounded-compressed.

The facial part of the lachrymal bone is longer than deep, and the lateral anterior part of the frontal is wide and obtuse, and extends anterior to the lachrymal. The nasals extend posteriorly to terminate in an acute angle which is above the anterior edge of the orbit. The frontopariëtal suture extends across the space between the anterior temporal ridges at a point half way between the anterior border of the orbit and the anterior glenoid margin. The malomaxillary suture has no anteroinferior process. The mastoid forms a distinct mass between the exoccipital and squamosal. The sutures are largely coössified.

The infraorbital foramen is above the contact of the third and fourth premolars. The space between the frontal foramina is about one-sixth the interorbital width. There is a large postpariëtal foramen on the pariëto-squamosal suture, and there are two small postsquamosal foramina, in line above the posttympanic tuberosity. The mastoid foramen is small, and is not situated in a fossa of any extent, as is the case with the species of the Oreodontinæ. There is a large foramen intermediate in position between that of the anterior condyloid and the jugular. Anterior and a little external to it and slightly elevated between the confluent base of the paroccipital process and the otic bulla is another foramen, perhaps the jugular. Between the posterior base of the bulla and the basisphenoid, is a smaller foramen, probably the carotid. The other foramina are yet concealed by the matrix.

The teeth do not differ in their form from those of other species of the genus. The second and third premolars have triangular bases, the second the narrower. The first has two roots. It is accidentally lost from one side, which circumstance led me to suppose at one time that this species has but three premolars above. The fourth premolar has its posterior external V well developed, though a little smaller than the anterior. In the

specimen now described, the posterior internal rudimental cusp is quite well developed; in the two other specimens now before me it is not so large. The superior canine is elongate, and not very robust, and its convex anterior border is directed partly posteriorly at the apex. The enameled portion of the crown is quite short. The premaxillary bones are narrow and weak, and are separated so as not to be in contact on the middle line. Its border displays two minute alveoli, from which teeth have been shed. I do not suppose that their presence is constant in the species. The external alveolus is twice the diameter of the internal. The inferior incisors are of normal number, but are very narrow, and much crowded. The canines are very narrow, but are longer than the incisors. The first inferior premolar is more caniniform than in any other species of Oreodontidæ known to me. The crown is a compressed oval in section, and is not expanded at its base. It is enameled to within 5 mm. of the alveolar border. A considerable diastema separates it from the second premolar. The description of the remaining teeth I take from a separate ramus of similar dimensions, as they are concealed in the type by their position in juxtaposition with the cranium. The cusps of the true molars are pyramidal and acute, and entirely separate from each other. The external faces of the external are convex, their internal faces flat. The external faces of the internal are convex, the internal faces concave at the base, and convex near the apex. The anterointernal angle of the posteroexternal cusp extends to the base of the anterointernal cusp. The only difference between the first true molar and the fourth premolar, is that the anterior crest of the anteroexternal cusp is continued round to the front of the anterointernal cusp, and to the internal side of the crown; and the apices of the two anterior crests are separated by a shallow notch. The second inferior premolar has two roots. The heel of the third true molar is well developed, and is convex posteriorly.

Measurements.	M.
Length from occipital condyles to postglenoid process..	.038
" " " " " preglenoid border ...	.058
" " " " " postfrontal process.	.104
" " " " " canine, inclusive	.226
" " orbit to canine inclusive	.085
" of mandibular ramus from condyle............	.176
" "symphysis mandibuli below.................	.049
Width of occipital condyles inclusive..................	.046
" " occiput above	.045
" " between otic bullæ....................	.016
" " at postglenoid processes inclusive...........	.079
" " of skull above glenoid surfaces..............	.100
" " " below orbits.........................	.099
" " " between orbits.......................	.068
" " " at fundus of canine alveoli...........	.040

Measurements.	M.
Width of skull between last upper molars, inclusive....	.070
Depth of occiput to foramen magnum.................	.043
" " " " basioccipital bone.................	.058
" " skull at last superior molar, exclusive........	.058
" " " " first premolar, exclusive............	.055
" " ramus mandibuli at front of M. iii...........	.035
" " " " " " " P-m. iv........	.027
" " zygomatic arch above glenoid facet..........	.027
Diameters of base of crown of superior canine { anteroposterior..........	.009
{ transverse.	.0085
Length of superior diastema...........................	.022
" " premolar series..............................	.039
" " true molar series...........................	.043
Width of premaxillary bones together.................	.043
Diameters of base crown inferior P-m. i; anteroposterior..	.0085
Length inferior diastema...............................	.015
" " last three premolars..................	.031
" " true molars.........................	.046
" " last true molar......................	.021
" " third premolar......................	.009
" " fourth................................	.012
Horizontal diameters of otic bulla { anteroposterior. ..	.019
{ transverse........	.017

The specimens of this species which I have seen, are from the John Day river, and were obtained by Messrs. Sternberg, Wortman and Davis. The skull from which the above description was taken is the most perfect one of the genus Agriochœrus which has yet been found.

Agriochœrus ryderanus Cope.

Coloreodon ryderanus Cope, Bulletin U. S. Geological Survey Territories, vi, p. 173.

This species is represented in my collection by three nearly complete skulls without mandibular rami. While of the general size of the *A. guyotianus*, this species displays various well marked peculiarities. The most important of these are (1) the shape of the otic bulla, in which it differs from all other known Oreodontidæ; (2), the position of the infraorbital foramen, in which it resembles in this genus only the *A. trifrons;* (3), in the form of the nasal bones posteriorly, in which it differs from the species where this part is known; (4), in the form of the palatonareal border; (5), in the form of the postglenoid process; (6), in the outline of the section of the frontal bone.

Agriochœrus ryderanus has the muzzle compressed laterally and flattened on top, as seen in the *A. guyotianus* and *A. trifrons*, and the side of the

muzzle has three distinct fossæ. The largest of these is above the position of the fundus of the superior canine alveolus; the second is below the fundus; and the third is behind the position of the infraorbital foramen, and above the third and fourth premolars, and the first true molar. The lachrymal region is plane, and the nasals are flat. The frontal bone is nearly flat in section between the posterior borders of the orbits, but each is decurved to the lachrymal opposite the anterior border of the orbit. There is no indication of the three planes of the infraorbital region characteristic of the *A. trifrons*, nor of the median convexity of the *A. guyotianus*. The anterior temporal ridges commence about the middle of the width of each frontal bone, and unite after a shorter independent course than they have in *A. guyotianus* into a long, narrow saggital crest. This bifurcates posteriorly into two prominent lateral crests, which are directed downwards and soon terminate, but which send forwards and downwards a delicate posttemporal crest. This passes without interruption into the superior edge of the zygomatic arch. This arch is not expanded either upwards or laterally, and is rather weak. The external face of the malar bone is gently concave, and the inferior edge is rather wide, is truncate, and grooved along the middle. The occiput is deeply concave between the crests, and below them is gently convex. The superior edge of the foramen is deeply notched at the middle, much as in *M. guyotianus*.

The occipital condyles are large, and their inferoanterior angles are produced horizontally for a short distance, forming short processes which are separated by a concavity of the basioccipital bone. The latter is plane below, but anteriorly develops a low meridian angle, which, widening on the sphenoid, causes its inferior face to be convex. The posttympanic element is distinguishable from the mastoid by a superficial groove, and a slightly free apex, and the mastoid from the paroccipital by a slight groove. The external base of the paroccipital extends but 5 mm. external to the line of the external border of the occipital condyles, and is therefore much less prominent than in the majority of species of Oreodontinæ. The base of the paroccipital has a posterior and an anterior face, nearly at right angles with each other. The latter is continued into the pinched posterior prominence of the auditory bulla, and encloses on its external side, with the apex of the posttympanic, the deep stylohyoid fossa. The tympanic bone is represented by a tuberosity below the meatus, and a laminar expansion on the posterior face of the postglenoid process. The otic bulla's long axis is inwards, and a little posterior from the internal side of the postglenoid process, from which it is separated by a narrow interval. The bulla is constricted at right angles to its long axis, in two parts. The external part is subglobular with the side next the postglenoid process flattened. The internal part is roughened, displays a flat side posterointernally, and has an apical keel which extends posteriorly and a little externally into the base of the paroccipital processes. This form is not known in any other species of the family. The postglenoid process is more robust than in either *M. guyotianus* or *M. trifrons*. Its width and thickness are equal,

and are a good deal longer than its height; in the species named the height equals the other measurements. The pterygoid ala rises opposite the middle of the end of the glenoid surface, and the angle of its junction with the pyramidal process of the palatine is considerably in front of the middle of the trough of the posterior nares. Its edge posterior to this angle is shallowly grooved. The palatonareal border differs from that of any other species of the family known to me. It is acute in front, forming a Gothic arch, its apex being opposite the middle of the superior third true molar. In a young *M. guyotianus*, the only specimen of that species in which it is perfectly preserved, it is rounded, and extends to the posterior part of the second true molar. In an adult specimen, where the middle portion of the margin is lost, it extended at least as far forwards; but its form is uncertain. The palate in the *A. ryderanus* is strongly concave throughout.

The lachrymal bone has a different form from that of a *A. guyotianus*, more resembling that of *A. latidens* figured by Leidy. Its anterior superior angle is not produced, and its outline is a little deeper than long. The anterior lateral prolongation of the frontal extends beyond it by nearly its width, and is wide, and terminates in an obtuse angle. The posterior edge of the nasals is broadly rounded, truncate at the middle, and is situated much in advance of the frontal foramina. The pariëtal is in contact with the alisphenoid. The squamosal does not extend beyond the vertical line from the base of the paroccipital process.

The infraorbital foramen is above the anterior edge of the third superior premolar, a position only seen elsewhere in the genus *A. trifrons*. The superior border of the orbit is concave and short as in *A. guyotianus*, and not straight and flat as in *A. trifrons*. The frontal foramina are above their middle, and their distance apart goes 4.5 times into the interorbital width. There is a large postpariëtal foramen on the pariëtosquamosal suture, and a large postsquamosal immediately below it. This arrangement differs from that seen in the other species here described, where there are two or three postsquamosals well posterior to the postpariëtal. Mastoid foramen small. There are two palatine foramina on each side of the mouth, one opposite the posterior edge of the second premolar, and one opposite the posterior part of the fourth premolar. The anterior condyloid foramen is large. On one side is a small posterior condyloid, the only occurrence I have met with in the family. The foramen lacerum posterius is not divided into three foramina as in the *A. guyotianus*, but remains open as in the species of *Eucrotaphus* and *Merycochœrus*. It shows its nearer affinity to the first named species, however, in its triradiate outline; and in the three grooves of the side of the bulla, which correspond to two of the three foramina. The *f. lacerum anterius* is not large, and is oblong in shape. The ovale is rather small, and is entirely bounded on the inner side by the pterygoid ala of the sphenoid. The *f. rotundum* is large and rather posterior. It is not bounded below by a transverse shoulder as is seen in the species of Merycochœrus, but is continued into a longitudinal groove, whose

external wall is longer than in any of the other genera of the family, extending to a point half-way between the inferior edge of the foramen and the middle of the last superior true molar tooth. It is curved both inwards and downwards just posterior to the foramen.

The superior molar teeth do not differ from those of *M. guyotianus*, *M. antiquus* and *M. latifrons*. The canines are very robust, and are separated from the first true molar by a considerable diastema.

Measurements.	M.
Length from occipital condyles to line of postglenoid processes	.046
Length from occipital condyles to line of preglenoid border	.060
Length from occipital condyles to line of postfrontal process	.110
Length from occipital condyles to line of canines, inclusive	.220
Length from orbit to canine inclusive	.076
Width of occipital condyles inclusive	.050
" " occiput at paroccipitals	.031
" between otic bullæ	.015
" at postglenoid processes inclusive	.093
" of skull above glenoid surfaces	.110
" " " below orbits	.094
" " " between orbits	.064
" " " at fundus of canine alveoli; about	.029
" " " between last upper molars, inclusive	.080
" " palate at second true molars	.033
" " " " third premolars	.031
" between superior canine	.021
Depth of occiput to foramen magnum	.038
" " " " basioccipital	.057
" " skull at last superior molar exclusive	.050
" " " " first premolar, exclusive	.046
" " zygomatic arch above glenoid facet	.021
Diameters base crown superior canine { anteroposterior	.014
Diameters base crown superior canine { transverse	.012
Length diastema to first premolar	.0185
" premolar series	.0365
" true molar series	.045
Diameters P-m. iv { anteroposterior	.011
Diameters P-m. iv { transverse	.014
Diameters M. i { anteroposterior	.014
Diameters M. i { transverse	.015
Diameters M. iii { anteroposterior	.018
Diameters M. iii { transverse	.021

The skulls of this species came from the John Day bed of the John Day river, Oregon, and were found by Mr. J. L. Wortman. The species was established on an immature individual. The adults show that it belongs to this genus.

COLOREODON Cope.

Proceedings American Philosophical Society, 1879, p. 375.

Superior premolars three, the fourth with two external Vs, no facial vacuities.

The mandibles of the species of this genus are unknown, so that the character of the inferior dentition is unknown. The otic bullæ are also destroyed in all the specimens, so that their character is unknown.

In its reduced dental formula this genus represents one stage of that specialization which Owen has shown, has overtaken all the modern types of Mammalia. In this series this process seems to have stopped at this point, and not to have gone further, as the entire line has come to an end.

The first superior premolar probably exists in a rudimental condition for a short time, and is early shed. The same state of things has been found to exist as an abnormality on one side in the *Agriochœrus guyotianus*, and may be found again, but not so as to invalidate the characters of the genus Coloreodon.

Two well-marked species of this genus have been described, which differ as follows:

Smaller; palatonareal border opposite posterior cusps of second true molar; sagittal crest anterior, commencing opposite optic foramina.. ....*C. ferox.*

Larger; palatonareal border opposite posterior cusps of third true molar; sagittal crest posterior, commencing opposite preglenoid border..*C. macrocephalus.*

Coloreodon ferox Cope. Fig. 1, p. 505.

Proceedings American Philosophical Society, 1879, p. 375.

The size of *Oreodon culbertsoni.* Known from one skull from the North Fork of the John Day river, Oregon. C. H. Sternberg.

Coloreodon macrocephalus Cope.

Proceedings American Philosophical Society, 1879, p. 376.

Size of the *Eucrotaphus major.* The typical skull is from the North Fork of the John Day river. A second skull, lacking all the parts posterior to the anterior origin of the sagittal crest, is undistinguishable from the first. It was found at the "Cove" of the John Day river, Oregon. Both were obtained by Mr. J. L. Wortman.

GENERAL CONCLUSIONS.

From what is now known of the history of the Oreodontidæ, the following conclusions may be drawn. These are especially instructive as far as they go, since they involve the causes of the rise, great development, decadence and extinction of one of the best-marked types of Mammalia the world has seen. The history of this type involves more or less the history of the life of the North American continent during the Miocene epoch of Tertiary time. It moreover involves the laws which regulate the vital success of all types of life, and which express the causes of multiplication, of energy, of weakness, and of sterility.

Two lines of the family, the *Oreodontinæ* and the *Agriochœrinæ,* come to light simultaneously in geological time, the White River epoch, or the Oligocene. The latter is a higher type than the former in its more complex fourth premolars, while it is inferior in the non-closure of the orbits posteriorly. It may then be regarded as a parallel line. It has but two generic types, while the Oreodontinæ present us with seven. So far as yet known, the Agriochœrinæ did not continue as long as the Oreodontinæ, as will be shown in tabular form below.

In the progressive modifications of the Oreodontinæ series, the first step was the inflation of the otic bulla (genus Eucrotaphus). This was succeeded by the coössification of the premaxillary bones (genus Merycochœrus). These changes were accompanied by a regular increase in dimensions. The species of Merycochœrus are all of the largest size, and there are no small ones. The smallest species of Eucrotaphus are equal to the largest ones of Oreodon. The fourth genus Merychyus, while it loses none of the points already gained, shows a deficiency in its facial walls where vacuities appear. There is the greatest range of size here : with one species (*M. major*), as large as any of the Merycochœri, we have another as large as the usual Eucrotaphi (*M. zygomaticus*), and several one degree smaller, or as large as the largest Oreodons. In the next genus the facial vacuities have attained to an enormous size. The premolar teeth become smaller, and the weakness of the narrow symphysis of the lower jaw is made up for by its coössification. The size is reduced from equal to the smallest Merychyi, to that of the smallest Oreodons (genus Leptauchenia). In the next stage (genus Cyclopidius) the superior incisors disappear. Finally, the lower jaw is so reduced in front that it loses both incisors and premolars, in spite of its symphyseal coössification (genus Pithecistes).

The species may be thus arranged in accordance with their distribution in time.

White River Epoch. Oreodon gracilis ; O. affinis ; O. culbertsoni. Eucrotaphus jacksoni ; E. major. Agriochœrus antiquus ; A. major ; A. latifrons.

John Day Epoch. Eucrotaphus jacksoni ; E. major. Merycochœrus superbus ; M. leidyi ; M. chelydra, sp. nov. ; M. macrostegus, sp. nov

Agriochœrus guyotianus; A. trifrons, sp. nov.; A. ryderanus. Coloreodon macrocephalus.

North Fork of John Day River Epoch. Eucrotaphus trigonocephalus, sp. nov.; E major. Coloreodon ferox; C. macrocephalus.

Ticholeptus Beds. Merycochœrus montanus, sp. nov.; M. rusticus; M. proprius. Merychyus arenarum, sp. nov.; M. pariogonus, sp. nov.; M. zygomaticus. Cyclopidius simus; C. emydinus, sp. nov. Leptauchenia major; L. decora; L. nitida. Pithecistes brevifacies; P. heterodon; P. decedens, sp. nov.

Loup Fork Beds. ? Merychyus elegans; M. medius; ? M. major.*

The stratigraphic relations of these species may be represented under their generic heads in the following table:

	No. of species.	White River Epoch.	John Day Epoch.	? North Fork Epoch.	Ticholeptus Epoch.	Loup Fork Epoch.
Oreodontinæ.						
Oreodon Leidy	3	—				
Eucrotaphus Leidy	3	—	—	—		
Merycochœrus Leidy	7		—	—	—	
Merychyus Leidy	6				—	—
Leptauchenia Leidy	3				—	
Cyclopidius Cope	2				—	
Pithecistes Cope	3				—	
Agriochœrinæ.						
Agriochœrus Leidy	6	—	—			
Coloreodon Cope	2		—	—		
	35					

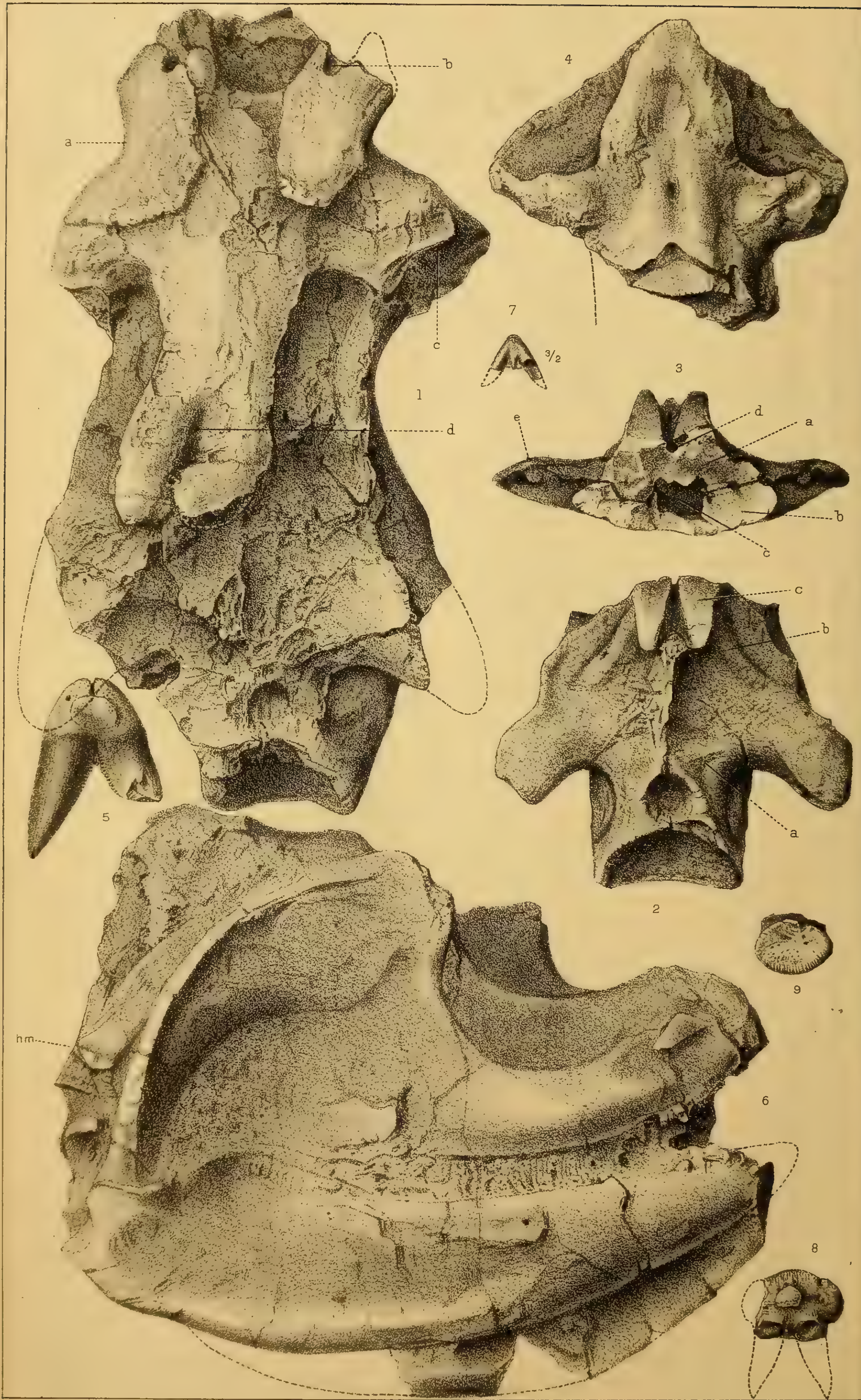
On the Structure of the Skull in the Elasmobranch genus Didymodus. By E. D. Cope.

(Read before the American Philosophical Society, March 7, 1884.)

The genus *Diplodus* was described by Agassiz from specimens of teeth from the European Coal Measures. In America, Newberry and Worthen† have described four species from the Carboniferous of Illinois and Ohio; and I have reported two species from the Permian beds of Illinois and Texas. Recently Mr. Samuel Garman has described a shark, said to have been taken in the Japanese seas, under the name of *Chlamydoselachus*

* The questions refer to the geological age.

† Geology of Illinois, vol. ii.



T. Sinclair & Son, Lith. Phila.

SKULL OF DIDYMODUS.

anguineus, whose teeth, as represented, do not differ generically from those of Diplodus. This is an interesting discovery, indicating that this genus, and not Ceratodus, is the oldest type of vertebrate now known in the living state.

My collections from the Permian beds of Texas include not only numerous teeth, but jaws and crania. Among these I recognize two types of teeth, which I cannot distinguish from those of the *D. compressus* Newb., and *D. gibbosus* Agass. Whether these species belong to the same genus, is a question which I will discuss at the close of this article. I provisionally refer the *D. compressus* to a distinct genus, Didymodus, and will so call it in this article.

The determination of the characters of this genus is a point of much interest The teeth resemble those of the existing sharks more than do those of any other genus of the Palæozoic ages, but the antecedent improbability of the modern type having existed at such an early period of the earth's history, is shown to be well founded by the present investigation, which also throws much light on the question of the general phylogeny of the fishes.

I. Description.

Twelve more or less complete crania of species of Didymodus are in my collection, and one set of jaws with small teeth and part of the cranium attached. One of the crânia, unfortunately much broken, exhibits also some large teeth. All were found by the late Jacob Boll in the Permian beds of Texas.

The skull of this species forms a continuum, which, however, displays distinct segments. First, however, as to the tissue of which it is composed. Both on the surface and in transverse fractures, it is more or less finely granular, the granules distinctly visible to the naked eye. These granules are composed of gypsum, as is also the matrix of a darker color in which they lie imbedded. Two hypotheses may be entertained regarding this structure. *First*, These granules may be regarded as the casts of coarse cartilage cells, and the matrix be in the place of the intercellular cartilage, replaced like the woody tissue in petrified wood. *Second*, The granules may be looked upon as replacements of osseous granules, such as cover the chondrocranium of most Elasmobranch fishes, while the matrix may be a replacement of the cartilage. The latter hypothesis is the more probable of the two, for two reasons: First, There is little probability of an unsupported chondrocranium retaining its form sufficiently long to permit the filling of its cells with a mineral deposit. Second, The granular type of ossification is well known in existing Elasmobranchs. It is only necessary to believe that the chondrocranium is penetrated by this kind of ossification. This state of things exists in the jaws also, which I describe later. This structure has already been observed by Kner in the genus Pleuracanthus.

The osseous cranium is abbreviated anteriorly, and elongated posteriorly,

The orbit occupies part of the anterior third of the length. It is bounded in front by an obtuse preorbital process, and posteriorly by a laterally expanded and decurved postorbital process. The latter bears an articular facet on its posterior and inferior face. The top of the muzzle is excavated by a fontanelle which does not extend posterior to a line connecting the preorbital processes.

There is a prominent cup-shaped occipital condyle. On each side of the cranium a short distance anterior to it, is a prominent process extending outwards and a little backwards, which is excavated on its inferior side, but whose posterior side is decurved, so that the inferior concavity looks partially forwards. Into this cavity, and abutting against the decurved posterior edge, is a lateral process of the basal axial bone of the skull, which I take to be homologous with the lateral alæ which occupy the same position in the sharks. Anterior to this junction no doubt the hyomandibular bone was suspended, for I suspect that it was articulated to a small condyle which is wedged into the fissure between the inferior and superior elements described, a centimeter anterior to their posterior extremities. This condyle is a distinct element of a subglobular form.

The interorbital plane is continued posteriorly, bounded on each side by a depression which probably corresponds to the temporal fossa of higher vertebrates. The edges of this plane are thus well within the lateral borders of the cranium. The plane rises a little posteriorly, and is split into two narrow wedge-shaped processes, which project freely upwards and backwards. The rather short remaining part of the roof of the skull has a keel or sagittal crest on the middle line, which descends gradually to the foramen magnum.

The base of the skull forms a continuum from the edge of the large occipital cotylus to the acuminate anterior extremity. The lateral basal alæ are subcylindric, and are separated from the basicranial axis by a fissure for a short distance, and then unite with it. Two or three foramina anterior to this reunion, are in line with the defining fissure just mentioned. The basis cranii sends out a process on each side below the postorbital processes, giving a cross-shape to this part of the base of the skull. Anterior to this point it is free from other elements and contracts to an acuminate apex.

The cranium is segmented, but a clean specimen is necessary to permit the straight sutures to be seen. In the first place, there is a distinct occipital bone, which includes exoccipital and basioccipital elements combined. The latter includes the large occipital cotylus, as in the Rhachitomous batrachian Trimerorhachis, and differs from the structure seen in the Lepidosirenidæ, where exoccipital elements only are present. The occipital extends but a short distance on the inferior face of the axis. It is preceded directly, and without imbrication, by a continuous axial element. If we recognize in the granular character of the tissue evidence of true ossification of the chondrocranium, we have here true continuous sphenoid and presphenoid bones.

Returning to the superior face of the cranium, we observe that the exoccipital elements form a wedge-shaped body, divided on the middle line by suture, with the apex forwards. Traces of this division are figured by Gegenbaur as present in Heptanchus.* Anterior to this the middle of the cranial roof is apparently occupied by another triangular bone with the base posterior and the apex anterior, and concealed beneath the free extremity of the element in front of it. The lateral sutures only are distinguishable, appearing as grooves (fig. 2). This is the pariëtal bone. External to this and the occipital, and filling the space behind as well as anterior to the postero-lateral angle of the pariëtal, is the element which is produced outwards and backwards as already described. Were I describing a true fish, this bone might be intercalare (epiotic) or pterotic. Perhaps it is both combined, or it may be the cartilage bone called by Günther, in Ceratodus, the "tympanic lamina." † The element anterior to the pariëtal is the cartilaginous representative of the frontal, and the fact that it terminates posteriorly in two free processes is significant of the true homology of the bones which terminate in like manner in the crania of the Lepidosirenidæ.‡ In this family and in the Ceratodontidæ these bones are more or less separated on the middle line by the median posterior element. In Ceratodus the separation is wide; in Lepidosiren the interval is uninterrupted, but narrow in front. In Protopterus these elements are in contact on the middle line, but diverge posteriorly. Bischoff, Stannius§ and Günther identify these elements with the frontals in the genera they have described. Huxley‖ calls them supraorbitals, so that it becomes necessary to name the median posterior element a fronto-pariëtal, as a combination of two bones usually found distinct in fishes. The furcate structure of the frontal cartilage in Didymodus goes to show that the identification by Bischoff and Günther is the correct one. There are also in this genus distinct paired membrane bones which do not take part in the bifurcation in question, and which appear to represent the frontals of Ceratodus. Each of these is a flat, subcrescentic supraorbital plate, which has a concave superciliary border. It is separated by a considerable interval from its fellow of the opposite side. Its anterior extremity is notched by a fossa which I suppose to represent the anterior (posterior in position) nostril. The ? frontal of the right side is displaced, and appears as a lamina lying on the frontal cartilage, showing that it is a membrane bone. From its relation to the nostril the question arises, whether it be not the homologue of the nasal.

For hyomandibular bone, palatopterygoid arch, and mandibular arch, we have to rely principally on one specimen. On one of the skulls, two

* Ueber den Bau des Schedels der Selachier, 1872, Pl. I.

† Philosophical Transactions of the Royal Society, 1871, p. 511, indicated on the plates by the letter *d*.

‡ *Lepidosiren paradoxa* by Bischoff, Prof. in Heidelberg; Leipsic, 1840.

§ Handbuch der Anatomie der Wirbelthiere; Rostock; Erstes Buch, die Fische, 1854, p. 49.

‖ Anatomy of Vertebrated Animals, 1871, p. 145.

curved rib-like bones lie parallel and divergent posteriorly on the right side of the frontal, in the temporal fossa. I cannot identify them. They are not present on the opposite side. As already described, there is a facet on the infero-posterior face of the postfrontal process. This indicates the point of articulation of the palatopterygoid arch, as it exists in the group Opistharthri of the sharks as defined by Gill, and as is clearly proven by the specimen now to be described.

This includes the entire palatopterygoid and mandibular arches of one side, and the greater part of that of the opposite side, together with a considerable part of the right hyomandibular bone and probable extremity of the ceratohyal. The anterior parts of both jaws support numerous small teeth, which closely resemble those described by Agassiz as belonging to his *D. gibbosus.* They differ from those of the *D. compressus* in their smaller size. The palatine bones do not project much beyond the mandible, which, taken in connection with the form of the muzzle above described, renders it probable that the mouth was nearly terminal.

In the palatopterygoid arch there is no noticeable separation or suture between the palatine and pterygoid elements. The inferior border of the palatine is swollen below the orbit; its superior plate rises into a strong suborbital ala, which is concave externally, with thin superior edge. This edge rises posteriorly, giving the outline an elevated convexity, whose greatest upward prominence is above a point a little posterior to the middle of the jaw, and which probably articulated with the postorbital process of the cranium. Its surface gives indication of an articular surface appropriate to the corresponding one of the cranium. The superior border then descends rapidly to a vertical posterior border, which forms a somewhat prominent rim. This descends to the mandible, forming a regular ginglymus, the mandible bearing the cotylus. The mandible is rather robust; its inferior edge is rather thin, and becomes incurved anteriorly. Its superior border is regular, except that it rises a little at the coronoid region, and is impressed, corresponding with a concavity of the surface, and arch of the border of the pterygoid region, just anterior to the posterior prominent ridge which forms its posterior edge.

The hyomandibular bone is only exposed for its inferior half. It issues from behind the palatopterygoid as a narrow shaft with obliquely truncate extremity.

It is thus evident that the arrangement of the jaws is as in the two exceptional existing genera, Hexanchus and Heptanchus.

The external nostril already referred to, is a distinct, rather small fossa, on the lateral part of the superior face of the muzzle, near the extremity of the osseous portion. It is visible on both sides of the best-preserved specimen. It is continued forwards as a shallow groove. At the apex of the muzzle, is a fossa looking downwards, where roofed on each side by the ? nasal bones, which may represent the posterior nasal cavity. Or the latter may probably be represented by a lateral fossa just in front of the preorbital process. In either case it is evident that the nares are separated,

and that the posterior one cannot be said to be within the oral cavity, as is the case in the known families of the Dipnoi. It is probable that there is a frontoparietal foramen at the posterior bifurcation of the frontal bones, corresponding to the conarium or pineal body of the brain. In a cranium broken across just anterior to the bifurcation, a canal passing forwards and downwards is exposed. There is a foramen, or possibly only a deep fossa on each side of the middle line on the occipito-sphenoid suture. The foramen magnum is rather small and opens upwards. Its border displays no articular surfaces. At the middle of a line connecting the posterior borders of the postorbital processes is a small shallow fossa, or probably foramen, from this there extends on each side backwards and outwards, a shallow groove apparently for a vessel, which terminates at the anterior one of three foramina already mentioned as in line with the fissure which distinguishes the lateral ala of the basicranial axis posteriorly. A similar groove connects the first and second of these foramina, and in one specimen the groove from the median foramen joins this connecting groove. In front of the median foramen is a rather larger one on the median line, situated at the fundus of a short longitudinal groove. It is placed just posterior to a line connecting the preorbital processes. The grooves easily become obsolete by weathering.

II. Affinities.

In determining the systematic position of this animal, it will be convenient to take a survey of the characters of the primary divisions of the fishes. In 1840 Bischoff published the first account of the osteology of Lepidosiren. In this description he called the frontal bones malars with a question, and the pariëtals frontopariëtals. He described the skull as having an os quadratum. In 1854, Stannius in the Handbuch der Zoötomie* correctly determined the frontals and pariëtals, and stated further that the "lower jaw and hyoid bone articulate directly with continuous processes of the chondrocranium." This appears to be the first correct description of the cranial structure of the Dipnoi. In 1864,† Huxley restated the view of Stannius as to the nature of the mandibular articulation; adopted the opinion of Bischoff that the frontal is a frontopariëtal, and took a new position in calling the frontals supraorbitals. He also restates in general, the description of the skull of the Holocephali already given by Stannius.

The system of Johannes Müller, adopted by Stannius, was a great improvement over preceding ones. It embraced, however, the error of including the Holocephali in the same sub-class (Elasmobranchi) with the sharks. This was adopted by Gill in 1861,‡ by Huxley in 1864§ and in 1871.‖ All of these authors adopt at these dates the sub-class Ganoidea.

*Erstes Buch, die Fische, p. 49.

†Elements of Comparative Anatomy, p. 210.

‡Catalogue of the Fishes of the East Coast of North America, p. 24.

§Elements of Comparative Anatomy.

‖The Anatomy of Vertebrated Animals, p. 120.

In 1871* the writer gave the following as the primary divisions of the sub-class Pisces: Holocephali, Selachi, Dipnoi, Crossopterygia, Actinopteri. The Holocephali was raised to an equivalency with the other sub-classes on account of the absence of distinct hyomandibular bone. The Dipnoi were defined by the median pelvic element, by the distichous arrangement of the segments of the pectoral and ventral fins, when present, on a median axis, and by the supposed presence of a distinct hyomandibular bone. The latter definition must be abandoned, for though an ossification exists, it has been shown by Stannius, Huxley and Günther, to be merely a deposit in the continuous chondrocranium. The sub-class Crossopterygia was substituted for the sub-class Ganoidea of Agassiz and Müller, as the latter was believed to have no actual existence as a division of fishes. After comparing the osteology of Polypterus, Lepidosteus and Amia, I remark (p. 320) "It is thus evident that the sub-class Ganoidea cannot be maintained. It cannot be even regarded as an order, since I will show that Lepidosteus, Accipenser, and Amia, are all representatives of distinct orders. I hope, also, to make it evident that Polypterus should be elevated to the rank of a sub-class or division of equal rank with the rest of the fishes and with the Dipnoi, already adopted." The sub-class Ganoidea has not yet fallen into disuse, but there are strong symptoms that it will do so.† Among others I select the following extract from Huxley's paper on the ovaries of the smelt, published in 1883.‡

"As is well known, Lepidosteus presents an example of a Ganoid with oviducts like those of the higher Teleostei; in *Osmerus*, on the other hand, we have a Teleostean with oviducts like those of the ordinary Ganoidei. It is tolerably obvious, therefore, that the characters of the female reproductive organs can lend no support to any attempt to draw a sharp line of demarkation between the Ganoids and the Teleosteans.

"Boas has recently conclusively shown that the same is true of the supposed distinctive character afforded by the conus arteriosus; and it has long been admitted that the spiral valve which has been described in the intestine of *Chirocentrus* is the homologue of that which exists in all the Ganoids, though greatly reduced in *Lepidosteus*. Indeed I am inclined to believe that the circular valve which separates the colon from the rectum in the smelt is merely a last remainder of the spiral valve. Thus, among the supposed absolute distinctions between the Ganoids and the Teleostei, only the peculiarities of the brain, and especially the so-called chiasma of the optic nerves, remain for consideration. My lamented friend Mr. Balfour, in the last of his many valuable labors, proved conclusively that the brain of *Lepidosteus* is, both in structure and development, a Teleostean

* Proceedings Amer. Assoc. Adv. Science, p. 326. Transac. Amer. Philosoph. Soc., p. 449.

† The term ganoid can be used as an adjective to describe the scales already known by that name, and thus be preserved.

‡ Proceedings Zoölogical Society of London, 1883, pp. 137, 138, 139.

brain. But it is singular that no one, so far as I know, has insisted upon the fact, not only that the Teleostean brain is essentially similar to that of the Ganoids, but that it is exactly in those respects in which the Ganoids and Teleostei agree in cerebral structure that they differ most markedly from the Plagiostomi and Chimæroidei.

"With respect to the chiasma of the optic nerves, the exact nature of that structure has not yet been properly elucidated either in the Selachians or in the Ganoids. But, whatever may come of such an investigation, the establishment of the existence of a true chiasma in the Ganoids, and of its absence in Teleosteans, can have but little bearing on the question of their affinities, since Wiedersheim has shown that a simple decussation of the fibres of the optic nerves, as in ordinary Teleosteans, takes place in many lizards."

In 1877* I proposed the following primary divisions of the fishes, and have seen no reason to alter my views as to their value as a correct expression of the affinities and diversities of this class of Vertebrata. The system differs only from that of 1871 in the consolidation of the Crossopterygia and Actinopteri into a single sub-class, the Hyopomata; and in a few corrections of the definitions given. They are as follows:

I. Suspensorium continuous with the cartilaginous cranium, with no hyomandibular. No rudimental opercular bone; no maxillary arch; pelvic bones present; axial series of fore limb shortened, the derivative radii sessile on the basal pieces; axial series of hinder limb prolonged in male.......................................*Holocephali.*

II. Suspensorium articulated with the cranium; no maxillary arch; no opercular nor pelvic bones; bones of limbs as in the last........... *Elasmobranchi.*

III. Suspensorium rudimental, continuous with cranium, supporting one or more opercular bones; cranium with superior membrane bones; no maxillary arch; a median pelvic element; the limbs supported by segmented unmodified axes..................................*Dipnoi.*

IV. Hyomandibular and palatoquadrate bones articulated with cranium, supporting opercular bones; a maxillary arch; no pelvic element; axes of the limbs shortened, the derivative radii sessile on the basal pieces..*Hyopomata.*

In the definition of the Dipnoi, it is necessary to make the correction in accordance with the best observations on fresh specimens, above referred to, as I have not been able to determine the question from dried specimens in the Hyrtl collection. The suspensorium cannot be properly said to be articulated to the cranium in the sense in which it is said to be such in the Elasmobranchi. In the latter it is articulated by ginglymus; in

*Proceedings of the American Philosophical Society, 1877, p. 25; and in the Annual Reports of the Commissioners of Fisheries of Pennsylvania for 1879-80, p. 67 and 1881-2, p. 111.

the Dipnoi merely by suture or contact, with other cartilage bones. Its character is therefore more nearly that of the Holocephali than of the Elasmobranchi or the Hyopomata.

In the light of the above considerations, to which sub-class must be referred the genus Didymodus? Does it possess a freely articulating hyomandibular bone, and maxillary, palatoquadrate and mandibular arches? The question must be primarily determined by these considerations, since the fins and their supports are unknown to us.

The lateral posterior processes of the skull are in its superior plane, and their extremities do not present an articular facet for the lower jaw. It is improbable that they were continued downwards as cartilage for the former articulation, as in the Holocephali and Dipnoi. Both from the presence of an articular condyle, and from the mechanical necessities of the case, I have little doubt but that there was a freely articulating hyomandibular bone. I have already described this element in fact as visible in a single specimen. The choice is thus limited to the Elasmobranchi and Hyopomata. It is decided in favor of the former by the absence of maxillary arch and of opercular apparatus. So then Didymodus is a shark, in spite of its peculiarities. Kner* speaks of the presence in the nearly allied Pleuracanthus (= Diplodus), of premaxillary and maxillary bones; but this is no doubt a misinterpretation of the homologies, as he says they *articulate with the lower jaw.* In my jaws there is but one bone on each side, a palatopterygoid.

In his researches on the structure of the skulls of sharks, Gegenbaur† shows the different methods of articulation of the palatopterygoid arch in the sub-class Elasmobranchi. In Heterodontus the palatopterygoid arch is attached to the skull throughout by its superior border, anterior to the orbit, but is free posterior to the orbit. In Hexanchus and Heptanchus it is free anteriorly, but articulates by its elevated posterior portion with the postorbital process. In the remainder of known recent Elasmobranchs it is free throughout, and merely in contact in front. These relations are also described by Huxley.‡ Professor Gill utilizes them as definitions of three (of four) primary divisions of the sub-class Elasmobranchi,§ which he names the Opistharthri, (fam. Hexanchidæ); Proarthri (Heterodontidæ); Anarthi (sharks proper); and Rhinæ (Squatinas). According to these definitions, Didymodus must be referred to the Opistharthri. The skull, however, presents other characters which must claim attention. Its

* Sitzungsberichte Wiener Akademie, LV, p. 540.

† Untersuchungen zur Anatomie der Wirbelthiere, Leipzic, 1872.

‡ On the Anatomy of Ceratodus. Proceedings Zoöl. Society of London, 1876, p. 43–4, with figures.

§ Bulletin of the U. S. National Museum, No. 16, 1883, p. 967. Gills fourth group, Rhinæ, does not appear to me to possess the value of the other three, nor are the "Raiæ" and "Pristes" more distinct. I therefore propose that the order Selachii, as defined in the following pages (of the sub-class Elasmobranchi), be divided into three sub-orders: Opistharthri, Proarthri and Anarthri, the latter to include the true sharks, the Squatinæ, the sawfishes and the rays.

reference to the Elasmobranchi is confirmed by the following characters: (1) The nares are not oral. (2) There is a large fontanelle on the summit of the muzzle. (3) There are processes corresponding to the lateral alæ of the basicranial axis.

In another character Didymodus differs from this and all other sub-classes of the Pisces. This is the penetration of the granular ossification throughout the chondrocranium.

In the following characters it agrees with the Dipnoi: (1) The distinct exoccipital, pariëtal, and frontal elements. (2) The occipital cotylus. (3) The posterior bifurcation of the frontal cartilage.

In the following characters Didymodus resembles the Hyopomatous or true fishes: (1) In the basioccipital bone with condyle. (2) In the ?os intercalare or pteroticum. (3) The presence of a distinct element articulating with the proximal end of the hyomandibular. (4) The presence of membrane bones in the position of frontals.

The characters above cited as constituting resemblances to the true fishes, will not, it appears to me, permit the reference of this genus to any of the divisions of sharks established by Prof. Gill. I therefore proposed a new order of the Elasmobranchi* for its reception, with the following name and definition.

A basioccipital bone and condyle. Occipital, ? pterotic, and frontal bones distinct. Supraorbital (or nasal) bones present............*Ichthyotomi.*

The remaining Elasmobranchi, in which the above characters are wanting, may be termed by way of contrast, utilizing an old name, *Selachii.*

Were it not for the probable presence of the free hyomandibular bone, the order Ichthyotomi might be regarded, in the absence of knowledge of its limbs, as the possible ancestor of the Rhachitomous Batrachia. But as the Batrachia have no distinct suspensorium, or are, to use Müller's convenient term, monimostylic, their origin must still be sought for in some yet undiscovered type of Dipnoi. It is on the other hand very probable that the Ichthyotomi are the group from which the Hyopomata derived their origin. The distinct basioccipital with its two foramina, the superior origin of the hyomandibular, and the superior nostrils, all point towards the true fishes. The tribe of Hyopomata which must be their most immediate descendents, are the Crossopterygia, as I define that division.

I must now compare the Ichthyotomi with such groups of the Hyopomata as they may be supposed to approach most closely. I begin by referring to the marine eels of the order Colocephali. In 1871† I characterized this order as follows: "Pariëtals largely in contact; opercular bones rudimental; the preoperculum generally wanting. Pterygoids rudimental or wanting; ethmoid very wide. Symplectic, maxillary, basal branchihyals, superior and inferior pharyngeal bones, all wanting, except the fourth pharyngeal. This is jaw-like, and is supported by a strong superior branchihyal; other superior branchihyals wanting or cartilaginous."

* American Naturalist, 1884, 413.

† Proceedings American Ass. Adv. Science, xx, pp. 328–334.

The statement "maxillary wanting," is in contradiction to the definition of the sub-class Hyopomata, which asserts the presence of those bones. Stannius* has asserted the absence of the "oberkiefer" in the eel; Günther† describes their presence. As the absence of the maxillary bone would constitute a point of resemblance, if not affinity to the Elasmobranchi, I have reëxamined my material to determine the homologies of the lateral dentigerous bone of the upper jaw of the eels. My specimens of species of the Colocephali include the following from the Hyrtl collection: *Myrus vulgaris; Sphagebranchus rostratus; Moringua rœtaborua; Murœna sp.; Murœna unicolor; Murœna sp.; Poecilophis polyzonus*, and *Gymnomurœna tigrina*. The pterygoid bone exists in a rudimental condition in the *Gymnomurœna tigrina, Myrus vulgaris*, and one of the species of Muræna; and whether lost in the preparation of the other crania or not, cannot be stated. In the *Anguilla vulgaris* the pterygoid bone is considerably larger, and extends to a point halfway between its base and the extremity of the muzzle. In the *Conger vulgaris* it extends still further forwards, reaching a transverse process of the anterior part of the vomer. No palatine bone appears. The premaxillary bone is not distinguished from the ethmoid in the Colocephali, nor in the Enchelycephali (Anguillidæ, etc.). It is quite possible, therefore, that the external dentigerous bone or upper jaw, in both of these orders, may be the palatine, and the maxillary be wanting. The family of the Mormyridæ appears to furnish the solution. In this group the structure and connections of the pterygoid bone are much as in Conger, and there are in addition distinct premaxillary and maxillary bones. It is clear that in this family it is the palatine, and not the maxillary bone, that is wanting. Similar evidence is furnished by the family Monopteridæ. The definition of all four of the orders, Colocephali, Enchelycephali, Ichthyocephali and Scyphophori must, therefore, embrace this character. The Gymnarchidæ agrees with the Mormyridæ in this respect, and both families have the transverse process of the vomer which receives the pterygoid, as in the genus Conger.‡ The supposed resemblance to the sharks presented by the Colocephali is then not real, and the question as to the point of affinity of the Ichthyotomi to the true fishes remains open as before.

I now refer to the remarkable characters presented by the deep sea fishes of the family Eurypharyngidæ, as recently published by Messrs. Gill and Ryder.§ These authors find the characters of the skeleton so remarkable, that they think it necessary to establish a new order for its reception, which they call the Lyomeri. The definition which they give is the following: "Fishes with five branchial arches (none modified as branchiostegal or pharyngeal) far behind the skull; an imperfectly ossified skull articulating with the first vertebra by a basioccipital condyle alone; only

* Handbuch der Zootomie, Fische 1854, p. 76.

† Catalogue Fishes, British Museum, vol. viii, p. 19.

‡ These transverse processes are enormously developed in Gymnarchus.

§ Proceedings U. S. National Museum, Nov. 1883, p. 262.

two cephalic arches, both freely movable ; (1) an anterior dentigerous one—the palatine, and (2) the suspensorial, consisting of the hyomandibular and quadrate bones ; without maxillary bones or distinct posterior bony elements to the mandible ; with an imperfect scapular arch remote from the skull ; and with separately ossified but imperfect vertebræ."

M. Vaillant came to no conclusion as to the affinities of this group ; and Messrs. Gill and Ryder remark, "We are unable to appreciate any affinity of Gastrostomus to any Anacanthines, Physostomes, or typical Apods, nor does it seem to be at all related to Malacosteus, which has been universally considered to be a little modified Stomiatid." It is, however, clear to me that the relationships of this family Eurypharyngidæ are to the order Colocephali, and that they represent the extreme degree of the modification of structure which that order exhibits. In other words, the modification of the ordinary piscine type which is found in the Anguillidæ (order Enchelycephali), is carried to a higher degree in the Colocephali, and reaches its extreme in the Eurypharyngidæ. The points of identity between the two groups last-named are so many, that it becomes desirable to ascertain whether they are susceptible of ordinal separation from each other. The characters above given to the order Lyomeri are in fact identical with those which define the order Colocephali, with a few possible exceptions. First, however, I note that the supposed palatine arch, is probably the maxillary, as in the Colocephali, and that it is the palatopterygoid arch which is absent. The five branchial arches exist in the Colocephali, but the three anterior are rudimental, and the basal branchihyal bones of the fourth and fifth are closely united. There are, however, five arches. There is a ceratohyal arch in Muræna and Gymnomuræna, but of very slender proportions. Whether this element is absolutely wanting in Gastrostomus, or whether the first branchial arch is its homologue, remains to be ascertained. Should the last two be coherent as in the Colocephali, we would then have the same number of hyoid arches in both, viz., six. The "imperfectly ossified cranium" is shown in the detailed description given by Messrs. Gill and Ryder, to support the same bones which are found in the Murænoid skull. The degree of ossification of the skeleton does not constitute a basis for ordinal distinction, if the same elements be present. For this reason the perforation of the vertebral centra by the remnant of the chordadorsalis does not seem to be of ordinal importance.

In the more detailed description, there are a few charecters worthy of notice. First, "The notochord is persistent in the skull for half the length of the basioccipital." This indicates further the primitive condition of the vertebral column, but scarcely gives basis for an ordinal definition. Second (p. 266.), "The neurapophyses are slender, diverging (instead of convergent), cartilaginous distally, and embracing the neural sheaths on the sides, while by the neurapophyses is supported a membranous sheath which roofs over the nervous cord," etc. The nerual canal is well closed above in the Murænidæ, but in the Anguillidæ it is largely

open above. The neurapophyses it is true unite, but at a distance above the neural cord, and as attenuated rods. Third, "There is no vomer developed, but a triangular cartilaginous element pendent from the cranial rostrum affords attachment for the palatine (read maxillary) element anteriorly," etc. This element probably exists in the Colocephali and similarly takes the place of the vomer, only differing in being ossified. I have been accustomed to regard it as the homologue of the bone called ethmoid in fishes.

The character which distinguishes the Colocephali from the Enchelycephali, now that their maxillary and palatine structure are shown to be essentially the same, is found in the hyoid apparatus. In the Enchelycéphali, the structure is as in ordinary fishes; there is a glossohyal, and there are basihyals, and axial branchihyals, and superior pharyngeals. In the Colocephali all these elements are wanting, excepting the fourth superior pharyngeal, which has the form of an antero posteriorly placed dentigerous jaw, which opposes the lateral branchihyal of the fifth arch or, as it is generally called, the inferior pharyngeal. It is evident that the Eurypharyngidæ are more similar to the Colocephali than to any other order in this respect also, but the description of these parts is not yet sufficiently detailed to enable me to determine what difference there may be in this respect, if any. The mobility of the quadrate bone on the hyomandibular cannot be regarded as of great systematic significance, although it is doubtless important in the economy of the fish.

It is then evident that the Eurypharyngidæ belong very near to, if not within, the order Colocephali. Towards the end of their description, Messrs. Gill and Ryder (p. 270), recognize this relationship, but deny that it indicates that this family is "from the same primitive stock as the Murænids." I incline to the belief that it is the ultimate result of the line of development of which the Anguillidæ form one of the first terms, and the Murænidæ a later and more specialized one.

It is therefore clear that the point of relationship of the Ichthyotomi to the true fishes is not to be found in the Eurypharyngidæ or the Colocephali.

In the following point Didymodus resembles Polypterus. The fossa above described as on each side of the basioccipital, is found in Polypterus. There it serves as a place of insertion of a strong ligament on each side, which is attached externally to the epiclavicle, and serves to hold the scapular arch in its place. A similar structure exists in the Siluirdæ, where the ligaments are ossified. It suggests for Didymodus a scapular arch suspended more anteriorly than in sharks, possibly even to the skull.

The genealogy of the fishes will then be as follows, first, however, it is to be understood that in asserting the derivations of one group from another, I mean that in accordance with the rule which I have termed "the doctrine of the unspecialized," the later type in each case is the descendant of the primitive and not the later sub-form of its predecessor. In this way is to be explained the apparent anomaly of regarding the

notochordal sturgeons as descendants of Crossopterygia, whose modern representatives are osseous. The primitive Crossopterygia, and probably even the Actinopteri, were doubtless as cartilaginous as are the existing sturgeons:

Hyopomata = { Actinopteri. Chondrostei. Crossopterygia. — Batrachia.

Elasmobranchi = { Ichthyotomi. Selachii. — Dipnoi.

Holocephali.

In this phylogeny, the Holocephali, which have not differentiated a suspensorium, are regarded as the primitive fishes; although the living representatives display some specialized characters, as, for instance, a membranous gill-cover which conceals the primitive slits. The line to the right continues the monimostylic character and passes into the reptiles, whose primitive types are also monimostylic, as Johannes Müller called them. In the later forms or streptostylicate reptiles of Müller (Lacertilia, Ophidia), the quadrate becomes freely articulated.*

In the left hand series, the Elasmobranchs immediately present us with the free suspensorium or hyomandibular, which is a well-known character of the remainder of the line, the modifications being the addition of separate elements, as the metapterygoid, "quadrate," and symplectic.

The penetration of ossification into the chondrocranium of Didymodus, in regions not ossified in either fishes or batrachia (sphenoid and presphenoid), and into regions not ossified in any vertebrate (frontal and parietal cartilages), may be, so to speak, only a local phenomenon, and not indicative of extensive phylogenetic consequences. For if it be so regarded, it evidently proves too much, giving affinities in the base of the skull to the reptiles, and in the roof exhibiting a character more highly developed than any known form of vertebrata.

The Ichthyotomi include, so far as yet known, but one family, the Hybodontidæ of Agassiz. According to that author this family includes four genera, Hybodus, Pleuracanthus, Cladodus and Sphenonchus. It ranges from the coal-measures to the Jura inclusive.

The genus Didymodus may be described as follows:

Frontal plane well defined on each side by the temporal fossæ, and terminating in two cornua posteriorly. Anterior nares on the superior surface of the muzzle. Supraorbital (or nasal) bones well separated on the median line and constituting the only membrane ossification. Teeth with large lateral denticles.

The species *Didymodus compressus* Newberry, may be defined as follows:

Skull with massive walls. Form elongate, depressed, the orbit not ex-

* The phylogeny of the Reptilian series can be found in the Proceedings American Association Advancement of Science, xix, 1871, p. 233. The Batrachia are supposed to be their ancestors.

tending behind the anterior third of the length. Basicranial and basifacial axes in one line, flattened, the supraorbital border flat, concave on the edge; postorbital processes obtuse, the temporal ridges commencing with thin posterior border, which they excavate. The ridges then turn, extend parallel posteriorly, terminating in the horn-like processes already described, with a slight divergence. The apices mark the posterior third of the length of the skull. The occipital condyle is wider than deep, and its superior border retreats forwards so as to cause its cup to look upwards. The exoccipital diameter at the foramen magnum is less than that of the basicranial axis, the osseous element of which, probably sphenoid, is recurved on the sides to their middle. The sides of the latter expand a little to meet their lateral alæ. Immediately above their contact is situated the supposed condyle for the hyomandibular element. The basicranial axis is convex opposite the postorbital processes, from the bases of which a concavity separates it. It has a slight median groove at this point. It is much narrower than the interorbital width above. A short distance in front of the postorbital processes it begins to contract, and gradually reaches an acuminate apex. Superior to this apex, commencing posterior to it, the space between it and the supraorbital or nasal elements is occupied by a massive element (? ethmoid) which forms the floor of the nasal median fontanelle.

The surfaces are smooth, but readily weather so as to be granular. The granules are subround, with flattened surface.

Measurements of skull.	M.
Total length of skull to end of frontal bone (No. 1)	.180
" " " muzzle to orbit; axial	.024
" " " skull to postorbital process	.058
" " " " to apices of frontal cartilage	.117
" " " " to ? pterotic apex (axial)	.155
Width of skull at prefontals	.045
" " " " supraorbital borders	.055
" " " " ? pterotic apices	088
" " occipital condyle	.034
Depth " " "	.025

Measurements of jaws.	
Length of mandibular ramus from cotylus, inclusive.	.145
Depth " mandibular ramus at cotylus	.028
" " " " " middle	.035
Length " palatopterygoid bone from cotylus, inclusive.	.145
Depth " " " at postorbital articulation	.071
Depth of palatopterygoid bone at orbit	.035
Length " " " posterior to orbit	.070

A second species has been brought to light by the researches of Mr. W.

F. Cummins in the Permian beds of Texas. Parts of the jaws with two of its teeth are preserved. The lower jaw is distinguished from that of the *D. compressus* by its small transverse as compared with its other diameters. The ramus is quite compressed, and is not thicker at the inferior edge than the superior, and is slightly concave on the inner side. Its external face is nearly vertical. The angle is rounded forwards, and there is no angle behind the cotylus, which is raised above the superior line of the ramus. The cotylus is rather large, and has a shallow anterior superior, and a posterior subposterior facet. There is no indication of a coronoid process. The inferior edge of the ramus is swollen on the outer side, below the anterior border of the condyle, so as to mark with the thickened posterior edge of the ramus a fossa in the position of the masseteric.

The teeth are pecular in the form of the root (Figs. 8–9). This part has no anterior projection, and the posterior portion is a flat, thin-edged plate, wider than long. It carries a button, but no notch. There is a minute median denticle. The form of the root is thus very different from that of the tooth of the *D. compressus* (figs. 5, 7).

Measurements.		M.
Depth of ramus at cotylus (vertical)		.062
" " " 120 mm. anterior to cotylus		.048
Transverse diameter at the same point		.009
Long diameter (oblique) of cotylus		.031
Diameters of base of tooth	anteroposterior	.011
	transverse	.037
Diameters of crown of lateral denticle	anteroposterior	.0048
	transverse	.006

I call this species *Didymodus platypternus.* Should the name Didymodus be found hereafter to apply to species of Pleuracanthus, the latter generic name must be used for this species.

III. Historical.

In 1837 Prof. Agassiz (Poiss. foss., iii, 66), described a spine which he believed to have belonged to a fish like the sting-rays, as *Pleuracanthus lævissimus.* The only example was obtained from the Dudley Coal field.

In 1845 Prof. Agassiz (Poiss. foss., iii, 204), made known certain teeth, which he referred to sharks of the family of Hybodonts. Two species were distinguished, *D. gibbossus* and *D. minutus.* Both were obtained from the English Coal measures.

In 1848 Prof. Beyrich (Berichte vernandl. k. Preuss. Akad. wiss., 1848), proposed the generic name Xenacanthus for a German Carboniferous form, referred to Orthacanthus by Goldfuss (1847), but which approached nearer to Pleuracanthus.

In 1849 Dr. Jordan (Jahrbuch für Min. u. Geol., p. 843), described, under the name *Triodus sessilis,* a form subsequently ascertained to be identical with the Xenacanthus.

In 1857 Sir Philip de Malpas Gray Egerton (Ann. and Mag. Nat. Hist., xx, 423), contended that the spines of Pleuracanthus belonged to the same fish as the Diplodus teeth, and that Xenacanthus was likewise referable to the same type.

In 1867 Prof. Kner (Sitzb. k. Akad. wiss. Wien, lv, 540–584), published a memoir, illustrated by ten plates, in which he proved that Diplodus and Xenacanthus were generically identical.

In 1875 Messrs. St. John and Worthen proposed the genus Thrinacodus for the *Diplodus incurvus* and *D. duplicatus* of Newberry and Worthen and the *T. nanus* St. J. and W., from Illinois.

In 1883, in the Proceedings of the Philadelphia Academy (p. 108), I proposed the name Didymodus for the *Diplodus compressus* Newberry.

In Science for 1884, p. 274 (March 7th), I called attention to the close resemblance of the teeth of this genus to those of the recent shark, called by Garman Chlamydoselachus, and expressed my belief in the identity of the two genera.

In the American Naturalist for April, 1884, p. 413, I gave a brief abstract of the characters of the skull of Didymodus, and proposed to regard it as the type of a new order to be called the Ichthyotomi.

In Science, 1884, p. 429 (April 11), Prof. Gill objects to the identification of the genera Didymodus and Chlamydoselachus; on the ground of the different forms of the teeth. He states that he doubts the pertinence of the two genera to the same order. He points out that the oldest name for Diplodus Ag. is Pleuracanthus Ag., and that the order Ichthyotomi had been already defined and named by Lütken, with the name Xenacanthini.

On these various propositions the following remarks may be made.

(1.) There is no generic difference to be detected, in my opinion, between the teeth which are typical of Diplodus Agass. and Thrinacodus St. J. and W. and the recent Chlamydoselachus. Differences there are, but apparently not of generic value. The identification of the recent and extinct genera rests, as far as this point goes, on the same basis as that of the recent and extinct Ceratodus.

(2.) At the time of my proposal of the name Didymodus, I was not convinced that fishes of this type bore the spines referred to the genus Pleuracanthus Ag. None of the authors cited figure any specimens which present both tricuspidate teeth and a nuchal spine. None of my ten specimens possess a spine. However, Kner describes two specimens as exhibiting both tricuspidate teeth and a spine, and Sir P. Egerton's statements (*l. c.*), on this point are positive. So we must regard Pleuracanthus as the name of this genus, with Diplodus as a synonym.

(3.) Diplodus being regarded as a synomym of Pleuracanthus, it follows that Chlamydoselachus Garm. is distinct, on account of the *different structure of the dorsal fin*, which is single and elongate in Pleuracanthus, according to Geinitz and Kner. The presence of the nuchal spine in Pleuracanthus is also probably a character of distinction, although we do not yet know whether such a spine is concealed in Chlamydoselachus or not.

(4.) The identity of Didymodus (type *Diplodus compressus* Newberry) and Pleuracanthus, may now be questioned. None of the specimens are figured and described by the authors above cited, as displaying an occipital condyle, or posterior frontal cornua. My specimens of *Didymodus compressus* do not exhibit teeth on the roof of the mouth, as Kner describes. There are no spines with the crania, although separate Pleuracanthus spines are not rare in the same beds. The teeth associated with the skulls, moreover, present a button on the superior side of the root (Fig. 5). Agassiz figures teeth of this kind as belonging to the *Diplodus gibbosus*. St. John and Worthen make these teeth typical of Diplodus, and confer the name Thrinacodus on those without the button, a character which I do not think a constant one. The latter name is then probably a synonym of Pleuracanthus. The button-bearing teeth are figured and described by Kner as occurring scattered, and in a somewhat different horizon from that of the Pleuracanthus specimens. In Germany, as in Texas, the button-bearing teeth are the larger. I suspect that the skull I have described represents a different genus from Pleuracanthus proper. This genus will not differ from Chlamydoselachus Garm., in the lack of other evidence; the teeth presenting only specific difference.

(5.) Of course, a study of the anatomy of Chlamydoselachus, which I hope Mr. Garman will soon give us, may reveal differences between that genus and *Didymodus;* but of these we know nothing as yet.

(6.) The order Xenacanthini was proposed by Geinitz (Dyas) for Pleuracanthus, on account of the supposed suctorial character of the ventral fins. This character is supposed by Kner to be sexual. In any case this division, whatever its value, must be subordinated to the order Ichthyotomi, as I define it.

EXPLANATION OF PLATE.

All the figures two-thirds natural size, except fig. 6, which is one-half larger than nature.

Fig. 1. Skull from above, right frontal bone displaced, and its anterior extremity broken off. Posterior apex broken from right frontal cartilage bone. *a*, Frontal or supraorbital bone, that of the right side displaced; *b*, anterior nostril; *c*, postfrontal facet for palatopterygoid; *d*, frontal fissure.

Fig. 2. Posterior part of skull of another individual, from above; *a*, occipital bone; *b*, pariëtal; *c*, a cornua of frontal bone.

Fig. 3. Anterior view of fig. 2, displaying section of brain case; *a*, frontal or pariëtal cartilage bone; *b*, sphenoid; *c*, brain cavity; *d*, frontopariëtal fontanelle; *e*, hyomandibular condyle (? pterotic bone).

Fig. 4. Anterior part of skull from below, of a third individual, displaying orbits and postorbital processes.

Fig 5. Tooth of *Didymodus compressus* Newb., natural size, posterior view.

Fig. 6. Palatopterygoid and mandibular arches of a fourth individual from right side, with *hm*, hyomandibular.

Fig. 7. Superior tooth of external row, without apices of two of the cusps ; from the palatine bone of the specimen represented in fig. 5 ; one-half larger than nature, anterior view.

Fig. 8. Tooth of *Didymodus platypternus* Cope, nat. size, from above posteriorly.

Fig. 9. Tooth of a second specimen of *Didymodus platypternus* from below.

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THE EXTINCT MAMMALIA

OF THE

VALLEY OF MEXICO.

Read before the American Philosophical Society, May 16, 1884.

ON THE

STRUCTURE OF THE FEET IN THE EXTINCT ARTIODACTYLA OF NORTH AMERICA.

Read before the American Philosophical Society, Aug. 15, 1884.

FIFTH CONTRIBUTION TO THE

Knowledge of the Fauna of the Permian Formation

OF

TEXAS AND THE INDIAN TERRITORY.

Read before the American Philosophical Society, Aug. 15, 1884.

BY PROFESSOR E. D. COPE.

FOR SALE BY A. E. FOOTE,
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47 p

The Extinct Mammalia of the Valley of Mexico. By E. D. Cope.

(Read before the American Philosophical Society, May 16, 1884.)

The following study is based primarily on an examination of the specimens contained in the Museum Nacional of Mexico, which I was permitted to make through the kindness of the Director of the Departments of Geology and Mineralogy, Professor Mariano Barcena. Through the mediation of the same gentleman, I obtained permission from Professor Antonio Castillo, Director of the School of Mines, to examine the corresponding material preserved in the fine museum of that institution. The knowledge derived from the study of the latter, reinforced the results I obtained from the study of the specimens of the Museum Nacional, so as to enable me to reach definite conclusions as to the definitions of various species which are represented in both collections. I wish to record the obligations under which I have been laid by both of these distinguished gentlemen. I have, through their aid, been enabled to make a comparison between the pliocene fauna of Mexico, and that of Buenos Ayres, and that of Oregon. The species of the Pampean fauna contained in my private collection, are those exhibited by Messrs. Ameghino, Larroque and Brachet, at the Exposition of Paris of 1878. My Oregon material is derived from the explorations of my parties under Messrs. Sternberg and Duncan, and those of Professor Thomas Condon of the University of Oregon, who kindly lent me his collection.

The collections of the museums of the City of Mexico, above mentioned, are derived from the locality Tequixquiac, and the specimens referred to in the following pages are to be understood as having been derived from that locality unless otherwise stated. Tequixquiac is situated on the northern edge of the valley of Mexico, north of the City of Mexico and the town of Zimpango, and east of the gorge of Nochistongo.

GLYPTODON Owen.

GLYPTODON, sp. indet.

A nearly complete carapace of this remarkable animal is mounted in the Museum Nacional, and a second, nearly as well preserved, is in the Museum of the School of Mines. Jaws and teeth occur in the latter museum. The discovery of this genus at this extreme northern locality is due to Dr. Antonio Castillo. It was first announced by Dr. Mariano Barcena in the Revista Cientifica of Mexico, 1882, I, p. 3. The extension of this far southern genus to the latitude of Mexico during the Pliocene (Pampean) epoch, is entirely consistent with the further distribution of the great sloths and llamas to the United States at the same time.

DIBELODON Cope.

Mastodon pars, auctorum.

Various attempts have been made to define as genera groups of species which are included within the limits of the genus Mastodon of authors. The first new name, Tetracaulodon, was introduced by Dr. Godman, who saw in the mandibular tusks of some individuals of the *Mastodon americanus* Cuv., ground of its separation from the genus Mastodon, in which he believed those teeth to be wanting. This division was adopted by Dr. Grant and others, but has not been generally allowed. The next division was that proposed by Dr. Falconer, who, however, did not employ the names proposed by him in more than a subgeneric sense. He distinguished two series in the genus Mastodon. In one of these, the P-m. 3, and the Ms. 1 and 2 present three transverse crests, while in the other division these teeth present four such crests. To these divisions he gave the names of Trilophodon and Tetralophodon respectively. The third attempt at division is that of Herr Vacek, who gives names to the two divisions of the genus in which the cross-crests are composed of tubercles or continuous ridges. These divisions he calls Bunolophodon and Zygolophodon respectively.*

I will refer to these divisions in reversed order. Those proposed by Vacek cannot be regarded as genera, and their author did not use them as such. The tubercular crest passes into the straight crest by insensible stages. The divisions proposed by Falconer are more distinct, but not sufficiently so to represent genera. This may be understood by reference to the second lower molar of the *Mastodon augustidens*, which is, in some individuals, three crested, and in others four crested. Some other species present the same difficulty. On this point I quote the remarks of Dr. Lydekker :† "The foregoing survey of such a large series of Mastodon molars has led to the conclusion that the very regular ridge formula given by Falconer will not always hold good in regard to the true molars,

* Vacek, Ueber Oesterreichische Mastodonten. Abh. der K. K. Geolog. Reichanstalt, vii, Heft iv, Wien, 1877, p. 45.

† Geological Survey of India, Series x, Vol. i, pt. v, 1880, p. 256.

though in the Indian species, at all events, it appears to be always constant in the milk-molars. We have seen that there is a tendency in the true molars of some of the Trilophodons (*M. falconeri*) to develop the talon into a fourth ridge, and in the Tetralophodons (*M. latidens* and *M. sivalensis*), a similar talon is developed into a fifth ridge, in the intermediate true molars." *M. humboldtii* Cuv. (*M. andium* Falc.*) shows a small fourth crest on the second true molar, according to Falconer.†

The lower incisor teeth, on which Godman relied for the definition of his genus Tetracaulodon, were shown by Harlan, not to be constantly present in the *Mastodon americanus*. In fact, no adult specimen has been described in which two inferior incisors are present. The single one observed is very rarely found in adults, being a character more frequently found in the young. It is in this species a remnant of a character elsewhere constant, which does not disappear quite so soon as the teeth of the whalebone whale, and superior incisors of the ruminant. But it is otherwise with other species referred to Mastodon. No specimens of the *Mastodontes angustidens, productus* and *longirostris*, are recorded, in which two inferior incisors are not present. For this reason the first and last-named were placed by Grant and others in the genus Tetracaulodon. Unfortunately this name was applied by its author to the *M. americanus* only, a species which cannot enter the genus furnished with a pair of persistent inferior incisors. It is also the type of Cuvier's Mastodon.‡ It thus unavoidably becomes a synonym of the latter.

There is no doubt that the presence of a pair of persistent inferior incisors defines a genus as distinct from one in which there is not a pair of permanent inferior incisors. I agree, therefore, with Grant and others, in separating the Mastodons which present this character from the genus Mastodon, under another generic head. I believe, also, that the presence or absence of a band of enamel on the superior incisors furnishes ground for the recognition of distinct generic groups, and would be so used in any other division of the Mammalia. It is often asked why it is necessary to multiply generic names on such grounds. My answer is simply an expression of the law governing the case, based on the supposition that when the species of animals and plants come to be fully known, the genetic series will be found to be uninterrupted, excepting by the presence or absence of characters which appear or disappear during the growth of a set of individuals, which we on this account call a species, or refer to a genus. The difference in the two cases consists in this: In the case of species, the characters are numerous and are matters of proportion, size, color, texture, etc., while in the case of the genus the character is single, and marks one step in the serial chain of structural modifications. In the case of the genus there is an actual addition or subtraction of some distinct

* Palæontological Memoirs of Falconer, i, p. 100, pl. 8.

† Loc. cit., ii, p. 15.

‡ Ossemens Fossiles, ii, p. 252, Ed. 1834: "Ann. Mus., 1806, viii, 272," teste Leidy.

part or piece of the organism.* If now we fail to notice these points or steps, we must abolish all genera. If we define some and fail to define others, our practice ceases to have the uniformity of a law, and we abandon the basis of scientific order.† One point, however, must be insisted on. In order that a character be usable for any purpose of definition, it *must define.* That is, it must belong to all the individuals referred to the species, genus, etc., defined, and must not be present in some individuals and wanting in others of those supposed to be defined by it. This being the case, adult animals only can be used for definition, as characters, especially generic, are added from time to time up to maturity. Sometimes only one sex can be considered, since the adult characters are in certain cases never reached by one sex or the other. This is often the case with insects. Moreover, some latitude for exceptional variations must be allowed. Thus, the exceptional absence of the last molar in a dog does not invalidate the definition of the genus Canis, M. $\frac{2}{3}$.

Of course, if all specimens of animals could be found, the definitions would all, or nearly all, be invalidated. But it is safe to assume that all the intermediate forms will not be found, so that the definitions of species will represent the state of our knowledge, and the results of the operations of nature in the preservation of individuals.

The case is somewhat different with regard to generic characters. As these involve the addition or subtraction of some part, having definite dimensions, it is quite possible to say when the latter is present or absent. Characters of this kind present the appearance of abruptness of transition, to which I have referred in my paper "On the Origin of Genera," and which gave rise to the formulation, by Professor Hyatt and myself, of the "laws of acceleration and retardation." When such change prevails throughout all the individuals of one or more species, a new genus has its origin. As a matter of fact, the creation of generic modifications has been exhibited, in the history of life, by many individuals nearly contemporaneously. As the change involves *but one character,* it offers a better opportunity for the formulization of the laws of evolution, than in the case of specific characters, which are more numerous.

The three genera of Elephantidæ, of which mention has been made above, will then be defined as follows :

Mastodon Cuv. Superior incisors without enamel band ; inferior incisors wanting. Type *M. americanus.*

Dibelodon Cope. Superior incisors with enamel band ; inferior incisors wanting. Type *D. shepardi.*

Tetrabelodon Cope. Superior incisors with enamel band ; inferior incisors present in the male at least. Type *T. angustidens.*

To the genus Mastodon must be referred the following species. For

* See "Origin of Genera," Proc. Acad. Philada., 1869, where this point is discussed.

† American Naturalist, 1884, July, p.

the dental characters of the Indian species I am indebted to Messrs. Falconer and Lydekker :

Mastodon americanus Cuv., N. America.
" *?borsoni* Hays, E. and S. Europe.
" *mirificus* Leidy, N. America.
" *falconeri* Lydd., India.
" *arvernensis* C. & J., Europe.
" *sivalensis* Falc., India.
" *latidens* Clift., India.
Dibelodon shepardi Leidy, California, Mexico.
" *tropicus* Cope, Tropical America.
" *humboldtii* Cuv., South America.
Tetrabelodon angustidens Cuv., India, Europe, N. America.
" *andium* Cuv., S. America, Mexico.
" *productus* Cope, SW. N. America.
" *euhypodon** Cope, N. America.
" *pentelici* Gaudry, SE. Europe.
" *perimensis* Falc., India.
" *pandionis* Falc., India.
" *turicensis*† Schinz, Europe.
" *campester* Cope, N. America.
" *longirostris* Kaup, Europe.

The condition of the inferior incisors is unknown in the *Mastodon atticus* Wagner, and *M. serridens* Cope, and *M. proavus* Cope ; and in some of the above species the presence of an enamel band on the superior incisors has not been established.

I may add that I do not perceive how the so-called genus Stegodon can be distinguished, as at present, by the number of crests of the intermediate molars, and by the presence of cementum. It will probably be necessary to look for other characters in order to sustain it.

Dibelodon shepardi Leidy.

Mastodon shepardi Leidy, Proceedings Academy Philadelphia, 1870, p. 98 ; 1872, p. 142.

Mastodon obscurus Leidy part, Report U. S. Geol. Survey Terrs. I, p. 330, Plate xxi.

This species was originally proposed on the evidence of a last inferior molar tooth from Contra Costa county, California, and a part of a superior tusk from Stanislaus county in the same State. Dr. Leidy subsequently abandoned the species. I however revived it in a synoptic table of the species of North American Mastodons in 1884. ‡

The fossils of the Museum Nacional of Mexico, examined by me, included

* American Naturalist, 1884, p. 525.

† Von Meyer is my authority for the presence of mandibular tusks in this species, = *M. virgatidens* Meyer.

‡ American Naturalist, 1884, p. 524.

a well-preserved lower jaw of a Mastodon, which presents both rami, and both the last true molars, and the entire symphysis. In the collection of the Ecole des Mines I saw a palate with the second and third true molars of both sides in place, and the superior incisor teeth, or tusks. Other fragments of jaws, with numerous isolated molars, were seen in these collections and in that of the college of the city of Toluca.*

From these specimens it is clear that the high valleys of Mexico were inhabited by a trilophodont mastodon, with a short decurved toothless symphysis like that of the *Elephas primigenius*, and with a band of enamel on the superior incisor tusks. The molars have the characters of those of the *Mastodon andium* of authors, and are of about the same size. The cross-crests are divided at the middle line only, and one half wears into a trefoil, while the other half wears into an oval, transverse to the long axis of the crown. The unworn crests are obtuse and not serrate; and there are no accessory tubercles besides those forming the lateral lobes of the trefoils. The size of the ramus and of the teeth is about that of the *M. angustidens*, and smaller than that of the *M. humboldtii*. The last inferior and last superior molars have but four cross-crests and a small heel. This I verified on several specimens.

A comparison of this species with those described, yields the following results: In the character of its molars it is identical with the *M. andium*, and differs from the *M. humboldtii* in the characters which distinguish the two species, as pointed out by Gervais.† That is, only one-half of each cross-crest wears into a trefoil, and the size is inferior. But it cannot be identified with the *Tetrabelodon andium*, because, according to Falconer,‡ that species possesses a long massive deflected beak containing an incisor tooth.‖ It is true that the specimen figured by Laurillard in D'Orbigny's voyage dans l'Amerique Meridionale, Pl. x, does not display a long beak and tusk, although the symphysis is much more pronounced than in the present species. But that plate is made from a drawing, and may thus be of doubtful authority. If correct, it may represent the female, or, as Falconer suggests, the young of the *T. andium*. The last inferior molar figured by Dr. Leidy, l. c., and formerly referred to a species under the name of *Mastodon shepardi*, has the character of the corresponding tooth of the Mexican species under consideration. The plate does not, however, represent the specimen satisfactorily in one respect. The trefoils are not sufficiently distinct, on account of the faint representation of their basal lobes. These nearly block up the cross valley, a fact not to be derived from an examination of the plate, but which is clearly seen in a cast preserved in the museum of the Philadelphia Academy of Natural Sciences.

* For the opportunity of examining the museum of this Institution I am much indebted to its President, Dr. Villada.

† In Castelnau's Expedition, 1855; Recherches sur les Mammiferes Fossiles de l'Amerique Meridionale, p. 14.

‡ Palæontological Memoirs, ii, pp. 226, 274.

‖ The lower jaw figured by Falconer, Mem. i, p. 100, from Buenos Ayres, as *M. audium* is clearly *M. humboldtii*.

This specimen also agrees with those in the Mexican museums in the small number of crests on the last inferior molar: four with a short rudimental heel. Another specimen of apparently the same species is described and figured by Leidy as having been brought from Tambla, Honduras.* This tooth is apparently anomalous in the contraction of the third cross-crest.

The range of this species may then be given as extending from California to the valley of Mexico, inclusive.

A species apparently allied to the *Dibelodon shepardi* is the *Mastodon serridens* Cope,† of which the typical specimen was brought from southwestern Texas. Premolar teeth of the same type were shown me by Professor Castillo, in the museum of the School of Mines. These came from a lignitic bed at Tehuichila, in the State of Morelos, of Loup Fork age. This epoch is indicated by the presence of the genera Protohippus and Hippotherium. The sharp, serrate edges of the crests distinguish the molar teeth from those of the *D. shepardi,* and as the species probably came from different horizons, they are probably distinct. A premolar mingled with those of *D. shepardi,* from the valley of Toluca, much resembles that of the *M. serridens.*

DIBELODON TROPICUS Cope, sp. nov.

Mastodon humboldtii? VonMeyer Palæontographica, 1867, Studien ueber das genus Mastodon, p. 64, Pl. vi. *Mastodon andium* Leidy, Proceedings Academy Philada., 1876, p. 38.

A second species of Dibelodon inhabited the valley of Mexico, of larger size than the *D. shepardi,* and differing somewhat in the dentition. Von Meyer describes and figures a ramus of a lower jaw, l. c., brought by Herr Uhde from Mexico, which has, according to Von Meyer, no mandibular tusk, and probably a short elephantine symphysis. A very similar ramus, containing the last molar tooth, was presented to the Philadelphia Academy of Natural Sciences by Dr. Isaac Coates, who obtained it from Tarrapota, on the Huallaga river, in Eastern Peru. The extremity of the symphysis of this specimen is broken away, but enough remains to show that it was probably short, and that there was no inferior incisor.

Reference to Von Meyer's figure shows that the last inferior molar has five well-developed cross-crests and a heel. The Peruvian specimen has the same character, the fifth cross-crest a very little more contracted than in Von Meyer's plate. Dr. Leidy describes the specimen as having four transverse ridges, besides a strong tubercular talon. But it seems to me that the talon is of such size as to be properly included in the cross-crests. On the same principle one might say that the *D. shepardi* has three cross-crests and a strong talon, as it has one less cross-crest than the *D. tropicus.* The additional cross-crest, and the superior size, distinguish this form as a species from the *D. shepardi.* Von Meyer perceived these differences, and referred his specimen to the *D. humboldtii.* I am fortunately able to

* Extinct Mammalia Dakota and Nebraska, Pl. xxvii, fig. 14.

† American Naturalist, 1884, p. 524.

make a comparison of his plate and the Peruvian jaw, with a well preserved jaw of the *D. humboldtii*, with perfect last molar and symphysis, from Buenos Ayres, in my collection. I am able fully to substantiate the characters already pointed out by Gervais, and to prove that the cross-crests of the molars form double trefoils, while those of the *D. tropicus* are like those of *D. shepardi* and the *Tetrabelodon andium.*

The species last named is said by Falconer (loc. sup. cit.) to occur in Mexico, and speaks of having seen a well preserved lower jaw from the State of Tlaxcala. I have not met with it.

The *Mastodon americanus* has not yet been found in Mexico. The most southern localities for the species known to me are Southern California, and near San Antonio, Texas. From the former region I possess a ramus with the last molar, presented to me by Mr. Scupham, of San Francisco; the other specimen was obtained from Mr. G. W. Marnock, of Helotes, near San Antonio, Texas.

ELEPHAS Linn.

ELEPHAS PRIMIGENIUS Blum.

This species, of both the thick and thin plated varieties, was once very abundant in Mexico. I have received a series of teeth from Candela, in the State of Coahuila, from Dr. Caspar Butcher, through my friend Dr. Persifor Frazer; and Von Meyer has pointed out the occurrence of its remains in the valley of Mexico. The museums of Mexico contain very numerous portions of skeletons of this species, which prove that it was far more abundant than the species of Mastodon. Up to this time this locality is the southern known limit of its distribution on the American continent.

APHELOPS Cope.

APHELOPS, sp. *Aphelops ?fossiger* Cope. Proceedings Academy Philadelphia, 1883, p. 301.

The right half of the mandible, with part of the symphysis of a rhinoceros, was found in the valley of Toluca, sixty miles west from the city of Mexico, and Dr. Barcena sent me a photograph of it a year ago. I published a notice of it as above cited, in connection with remarks on a rhinoceros skull which I obtained on one of the heads of the Gila river in New Mexico. On my recent visit to the College of Toluca, I had, through the kindness of Professor Villada, the opportunity of examining the jaw. Its characters do not differ much from those of the *Aphelops fossiger* Cope. It is considerably smaller, and has a very short diastema, but not shorter than in some jaws of the *A. fossiger*. The dimensions are as follows:

Measurements.	M.
Length of ramus from base of canine	.400
" " dental series with canine, less M. iii	.235
" " molar series, less M. iii	.200
" " true molars, less M. iii	.105

Measurements.	M.
Diameter of canine (transverse)	.027
" of P-m. ii	.007
Depth of ramus at P-m. iii	.070
" " " at M. i	.085
" " " at front of M. iii	.090

The matrix in which this jaw was found, is much like the Upper Pliocene material of Tequixquiac. It is therefore of probably later age than the true *Aphelops fossiger*, which is a characteristic Loup Fork species. Leidy describes (Extinct Fauna of Dakota and Nebraska, p. 230) a rhinocerus, probably an Aphelops, from California, under the name of *R. hesperius*. It is smaller than the Toluca specimen, but has a considerably longer diastema. Its geological horizon is uncertain.

I mention here that rhinoceroses, probably of the genus Aphelops, apparently existed in North America during the Pliocene period. Bones of a species having resemblances to the *A. fossiger* have been sent me by my assistant, George C. Duncan, from the Equus beds of the eastern part of the Oregon desert. The genus has been hitherto supposed not to ascend higher than the Loup Fork, or Upper Miocene beds. These bones are accompanied by teeth of a peculiar Hippotherium unlike those of any species of the genus known to me from the Loup Fork Miocene.

EQUUS Linn.

The remains of horses are very abundant in the valley of Mexico,* and represent four species. In the determination of these species it has become necessary to compare them with those hitherto found in North and South America. In making this comparison I exclude the species of Hippidium, which are all American, and whose molar teeth are easily distinguished by the equality in size of the internal columns; resembling in this respect the genus Protohippus.

When the species of the genus Equus differ in the characters of their superior molar teeth, the diversity is to be seen in the size and form of the anterior internal column. The anteroposterior diameter of this column, as well as the integrity or emargination of the internal border of its section, varies according to the species. The infolding or the borders of the lakes has a value, but a less constant one. The *Equus caballus* differs from all of the American extinct species, where the corresponding parts are preserved, in the great elongation of the face, which is expressed in the greater lengths of the diastemata anterior and posterior to the canine tooth in both jaws. Other characters may be observed in the relative lengths of the limb bones, the form of the occiput, etc. It has been shown by Leidy, Rütimeyer and others, that it is not always practicable to distinguish the species of horses by their teeth alone. A glance at Owen's

* This fact has already been made known by Von Meyer, Palæontographica, 1867, p. 70, and Owen, Transactions of the Royal Society, London, 1869.

plates of the dentition of the existing species of Equus*, shows the truth of this statement. Among the extinct species of Equus the range of variation is greater.

The following attempt at a discrimination of the species known to me, or so fully described as to be well known, must necessarily be regarded as provisional, until the skeletons are more fully recovered. American extinct species only are introduced :

I. Long diameter of anterior internal lobe of superior molars not greater than one third the long diameter of the crown.

Borders of lakes crenate ; internal anterior lobe notched on the inner side so as to be bilobate ; crowns a little curved ; large......*E. crenidens.*

II. Long diameter of anterior internal lobe more than one-third and not more than one-half the anteroposterior diameter of the crown.

a Crowns more or less curved.

Crowns wider than, or as wide as long ; enamel edges little folded........ *E. curvidens.*

aa Crowns straight or nearly so.

β Diastemata longer.

Crowns nearly square, enamel not very complex ; no facial fossa ; maxillary bone produced much beyond M. iii..................*E. caballus.*

ββ Diastemata shorter.

γ No facial fossa.

Crowns nearly square ; enamel not very complex ; maxillary bone little produced behind last molar ; smaller................................. *E. hemionus ; E. burchelli ; E. quagga ; E. zebra ; E. asinus.*

Crowns longer than wide on face ; enamel little complicated ; face and maxillary unknown ; large..........................*E. occidentalis.*

Crowns square ; enamel more folded than in other species ; face and maxillary unknown ; large......................................*E. major.*

γ A facial fossa.

Crowns nearly square ; enamel less complex ; maxillary short posteriorly ; smaller...*E. andium.*

III. Long diameter of anterior inner lobe more than half that of crown of molar teeth.

Crowns square ; enamel little complex (in Mexican specimens) ; diastemata and maxillary behind shorter ; no facial fossa ; large...*E. excelsus.*

Crowns square ; enamel little complex ; smallest species......*E. barcenæi.*

In using the above table it must be noted that gradations in the diameter of the anterior internal column (or lobe) exist, not only between individuals of the same species, but between different teeth in the same jaw. This diameter is always greatest in the last superior molar, and the characters of this tooth are such that they cannot be used in connection with the above table.

* Philosophical Transactions, 1869.

Before describing the Mexican species I make some notes on the others embraced in the above list:

Equus curvidens Owen. Of eight superior molar teeth from Buenos Ayres in my collection, two second premolars are perfectly straight, while the third true molar is the most curved. The other teeth exhibit different degrees of curvature. The area of the anterior internal column is not so flat on the inner side in any of them as in Owen's Plate (Voyage of the *Beagle*, Vol. i). My teeth have also a rather greater transverse diameter than Professor Owen's type.

Equus caballus L. The common horse differs from all of the extinct species of the genus from American localities where the muzzle is known, in the greater length of the latter, with its diastemata, of both jaws, and in the greater prolongation of the maxillary bone posterior to the last true molar. Appropriately to the anterior position of the molar series, the facial ridge commences above the middle of the first true molar. In an *Equus quagga* in my possession the ridge commences above the middle of the last premolar. The basioccipital bone is more compressed than in any species of the genus known to me.

Equus occidentalis Leidy. This species is represented in my collections by at least one hundred individuals, some of which have been lent me by my friend Professor Thomas Condon of the University of Oregon. They are nearly all derived from the Equus beds of the Oregon desert. Unfortunately there is no perfect skull. A few specimens from the same region I refer to the *Equus excelsus*, but as these are comparatively rare, I am safe in referring most of the bones to the other species. In these I find the following characters to separate the species from the *Equus caballus*: (1) The basioccipital bone is not compressed, and besides its inferior lateral angles it has a pair of lateral angles, one proceeding forwards from the inferior border of each *foramen condyloideum anterius*. (2) The fossa enclosed between the paroccipital process and the basioccipital, is deeper, and has a raised border in front which separates it strongly from the plane of the petrous bone. This is not found in *E. caballus*. I verify it in three separate occipital bones of the *E. occidentalis*. (3) The astragalus and other bones of the feet are smaller than in *E. caballus*; the first named intermediate in size between that of the horse and that of the quagga. The cannon bones, when of the same length, are more slender. (4) The inferior canine issues in direct contact with the last incisor, without the diastema seen in the horse; and the incisive arc is narrower and more produced. The symphysis is elongated not only forwards, but also posteriorly. The mental foramen is anterior to the bifurcation of the rami in *E. occidentalis*, posterior to it in *E. caballus*.

Equus major Dekay. Dr. Leidy leads us to infer (Report U. S. Geol. Survey Terrs., Vol. i, p. 244), that this species differs from the *E. occidentalis*, in the generally greater complication of the enamel folds. This I find to be the case in specimens from the Fish House, in the brick clay, near Philadelphia, and from the Big Bone Lick, Kentucky. Leidy

figures similar specimens from various parts of the Eastern and Southern States.

EQUUS CRENIDENS Cope, sp. nov.

This large species of true horse is represented by molar teeth and fragments of jaws belonging to two individuals preserved in the Museo Nacional of Mexico, and to two others preserved in the Escuela des Minas. The typical specimen includes the three premolars of the upper jaw of an adult in perfect preservation.

The species is primarily distinguished by the close and strong wrinkling of the enamel border of the lakes of the superior molar teeth. This wrinkling, or vertical plication, reminds one of what is seen in the *Elephas indicus.* This wrinkling is not found in the enamel edges which border the interior crescents on the inner side, nor in those bordering the internal lobes or columns. The borders of the lakes are not folded in the complex loops seen in *Equus major* Dek., but have the plainer looping seen in the *Equus tau* Ow. The grinding faces are nearly square. That of the second premolar is a rather shortened triangle, and less produced anteriorly than in the *E. tau.* The crowns of the third and fourth premolars are long and slightly curved.

The measurements show that this is one of the larger species of horse.

Measurements.		M.
Diameters of P-m. ii	anteroposterior	.0430
	transverse	.0305
Diameters of P-m. iii	anteroposterior	.0335
	transverse	.0340
Diameters of P-m. iv	anteroposterior	.0310
	transverse	.0350

The crimping of the enamel of the lakes distinguishes this species from the others of the genus.

From Tequixquiac.

EQUUS TAU Owen. Philosophical Transactions of the Royal Society, 1869; p. 565; pl. lxi; fig. 4.

Of this species there are preserved in the Museum Nacional five superior molars, some of which belong apparently to one individual. In the Escuela des Minas, the series is a fine one. There are two skulls lacking the occiput; one skull lacking the occiput and muzzle; parts of both maxillary bones with teeth, of one skull; and a single maxillary bone with teeth, of a fifth skull. The specimen mentioned under the second head, has teeth and palate preserved, as in the figure given by Owen of his *Equus conversidens,* and I suspect it was from this specimen that the photograph was taken from which Professor Owen's figure and plate were made. It is possible that his figure and description of the *Equus tau* were made from one of the maxillary bones mentioned under head three. I am not able to perceive the specific differences between these specimens. The character displayed

by Owen's *E. conversidens*, on which he relied to distinguish the species, may be the result of distortion. The maxillary bones of the type are loose and may be made to assume different angles to each other. The last superior molar is represented as unusually short by Owen. This appearance could be produced by the oblique angle of the aperture of the camera in photographing, due to its too anterior position. Be that as it may, I could detect no specific differences between the seven or eight specimens I examined.

The *Equus tau* is an average horse in all respects, presenting no very tangible characters by which to distinguish it from the existing species of the *E. asinus* and *E. zebra* group, so far as the parts which I examined go. It has the internal anterior column of the superior molar always less in diameter than half that of the crown of the tooth, and not characterized by any marked peculiarity. The borders of the lakes have an entering loop on each end of the inner border; of these the adjacent ones are well marked, and the remote ones little marked. External to the adjacent loops the borders of the lakes are a little crenate. There is a small internal median loop of the internal enamel border at the notch. The crowns of the teeth are a little wider than long, and they are not curved. The palate notch reaches as far forwards as the posterior border of the second true molar, and the palatal foramen is opposite the front of the third true molar. The latter tooth is a little longer than the other true molars. The second premolar is short and robust. The diastemata are rather short, as can be seen by the appended measurements.

Measurements.		M.
No. 1. Escuela des Minas.		
Length of precanine diastema		.020
Length of postcanine diastema		.074
Length of molar series		.151
No. 2. Museum Nacional.		
Diameters of P-m. ii	anteroposterior	.030
	transverse	.024
Diameters of ?P-m. iii	anteroposterior	.024
	transverse	.027
Diameter of ?P-m. iv	anteroposterior	.025
	transverse	.028

This species differs from the *Equus andium* Wagn., so fully described by Branco,* in the absence of a facial fossa. From *Equus caballus* it differs in the short diastemata, and the little posterior production of the maxillary bone. How it differs from the species of the *asinus* section I do not yet know.

EQUUS EXCELSUS Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 266; pl. xxi, fig. 31.

*In Dames and Kayser Palæontologische Abhandlungen, 1883, p. 110, Dr. Branco furnishes reasons for believing that the *E. argentinus* Burm. is the same species

A portion of a left maxillary bone supporting the true molars of a horse from the Oregon desert, received from Professor Condon, resembles closely the type specimen from Nebraska described by Leidy as above. Two skulls, in the two museums of Mexico already referred to, present the same dental characters. In identifying the Mexican with the Oregon and Nebraska horses, I wish to be understood as making a provisional arrangement only, for unfortunately the cranium of the North American horse with this dentition is yet unknown. The uncertainty attending a dental identification being admitted, I proceed to the description.

This species differs from the others, whose remains have been found in the valley of Mexico, in the elongate and flattened form of the lobe formed by the section of the anterior internal column of the superior molar. This long diameter generally exceeds the half of that of the crown of the tooth by one-eighth the latter, and is rarely so short as one half of the same. The loops of the lakes are few, including only one near the posterior borders near the internal side and one on the anterior border of the posterior lake. There is generally a little loop at the notch between the two internal lobes. Crowns straight, second superior premolar elongate and acute.

One of the crania is complete, lacking only the lower jaw, and the two third true molars. The other lacks all posterior to the palatal notch. From the former I derive the following characters:

The apex of the nasal bones is above the superior canine tooth. The posterior border of the nares marks the middle of the anterior column of the third premolar. The infraorbital foramen is above the posterior edge of the second column of the fourth premolar. There are two notches on the anterior part of the superciliary border; and there is a short exostosis on each side of the front, in line with the supraorbital border, in front of the preorbital border.

Measurements.		M.
Length from superior edge of foramen magnum to incisive border		.565
From posterior nares to incisive border		.300
Interorbital width		.166
Length of series of molar teeth		.191
" precanine diastema		.022
" postcanine "		.056
Width of palate at third incisors		.092
" " canines, inclusive		.075
Diameters P-m. ii	anteroposterior	.0425
	transverse	.0275
Diameters P-m. iii	anteroposterior	.032
	transverse	.034
Diameters M. iii	anteroposterior	.0335
	transverse	.029

The internal anterior column of the superior molars is longer and flatter than in the specimens of the North American horse, but I do not feel at liberty to propose a new specific name for the Mexican animal. The absence of facial fossa and short diastemata throw it into the series of the asses. From all these the large flat internal column distinguishes it. The presence of the loop at the notch of the internal border in the Mexican specimens distinguish them from Leidy's type and from one of Condon's specimens. A second one of the latter has a small loop at the point in question. The absence of this loop is given by Leidy as characteristic of the *E. occidentalis*, but only a small proportion of my specimens of that species are without it.

The Mexican specimens are from Tequixquiac.

EQUUS BARCENÆI Cope, sp. nov.

Two superior molars represent this species in the Museum Nacional, and two superior molars in the Escuela des Minas. A skull lacking all in front of the orbits inclusive, in the latter museum, probably belongs to the same species.

This horse is distinguished from all the others here mentioned or described by its small size. In the characters of its superior molars it is like the *Equus excelsus*. The anterior internal column is flat, and its anteroposterior diameter is five-eighths that of the crown of the tooth. The prism is straight. The lakes have the margin but little looped; the posterior notch of the anterior lake is trebled or triplex. The grinding face of the crown of the third superior molar is a little longer than the others.

Measurements.

		M.
Diameters of molar No. I	anteroposterior	.0215
	transverse	.0230
Diameters of molar No. II	anteroposterior	.022
	transverse	.022

From Tequixquiac.

I have dedicated this species to my distinguished friend Mariano de la Barcena, Professor of Geology in the National Museum and Director of the Meteorological Observatory of the City of Mexico.

PLATYGONUS Leconte.

PLATYGONUS ?COMPRESSUS Leconte.

A portion of the mandibular ramus of a species of peccary, apparently the above, was found at Tequixquiac, and is preserved in the museum of the College of Guanajuato. Dr. Alfredo Dugés, the distinguished professor in the college, called my attention to the specimen, and gave me a cast of it. Its dimensions are similar to those of North American individuals, as follows:

Measurements.

		M.
Diameters of M. i	anteroposterior	.0145
	transverse	.012

Measurements.		M.
Diameters of M. ii	anteroposterior	.017
	transverse	.014

HOLOMENISCUS, gen. nov.

Under the head of this genus I give a synopsis of the results of my study of the extinct Camelidæ of the American Pliocene epoch. I can compare the specimens from Buenos Ayres with those from Mexico and Oregon, and Branco and Owen have given detailed descriptions of specimens from Buenos Ayres and Mexico. From these sources I learn of the existence of the following generic forms of Camelidæ. I omit Protolabis Cope,* and refer it to a separate family—the Protolabididæ, on account of the presence of three superior incisors in each premaxillary bone, as in the primitive Ruminantia, combined with the presence of a cannon bone.

I. Premolar teeth $\frac{4}{4}$.

P-m. i separated by diastemata.................................*Procamelus.*

II. Premolar teeth $\frac{4}{3}$.

P-m. ii below wanting.......................................*Pliauchenia.*

III. Premolar teeth $\frac{3}{2}$.

Fourth inferior premolar triangular.................................*Camelus.*

Fourth inferior premolar composed of two crescents, which enclose a lake (an inferior P-m. 3?)..................................*Palauchenia.*

Fourth inferior premolar composed of two crescents, with two posterior tubercles behind them..............................*Protauchenia.*

IV. Premolar teeth $\frac{2}{1}$

Fourth premolar below triangular...............................*Auchenia.*

V. Premolar teeth $\frac{1}{1}$

Fourth superior premolar composed of two crescents.......*Holomeniscus.*

Fourth superior premolar consisting of a simple cone............*Eschatius.*

The position of this genus being determined as above, it remains to examine the material representing it, at my disposal.

In 1873 Dr. Leidy† described a large species of llama from specimens from California, which include the entire inferior series of molar teeth, and one superior molar. The first inferior molar, properly the fourth premolar, has the crown partially worn, showing that it was opposed by a grinding tooth in the superior series. In the Museum Nacional of Mexico is preserved a complete mandibular ramus, containing all the teeth of one side of an animal smaller than Dr. Leidy's type, but having a general resemblance to it; including the worn fourth premolar. In the collections of Professor Condon and myself from the Oregon desert, there are various isolated molars agreeing in measurements with Dr. Leidy's type, and belonging probably to the same species. In the Condon collection is part

* Proceedings Academy Philadelphia, 1876, p. 145.

† Report U. S. Geol. Survey Terrs., F. V. Hayden, 1, p. 255, pl. xxxvii, figs. 1–3.

of a superior maxillary bone which contains the M. i and the alveolus of the P-m. iv, with the foramen infraorbitale anterius. The measurements of the M. i agree with those of the corresponding tooth of the lower jaw of Leidy's specimen. In the Museum of Mexico, there are preserved several superior true molars which also agree in dimensions with the corresponding teeth of the lower series of the type of the same *A. hesterna* of Leidy. The fourth superior premolar is wanting from this series.

The fragment of maxillary bone in the Condon collection shows that this species had a large three-rooted fourth premolar. It is broken off at the anterior alveolus, but it is so attenuated at that point as to make it almost certain that there was no third premolar in front of it, as is found in the genus Auchenia.

In further evidence of the existence of a genus characterized as above, by the absence of the P-m. $\frac{3}{}$, the jaw-fragment which represents the *Auchenia vitakeriana** may now be cited.

Holomeniscus vitakerianus Cope.

Although I ascribed a third superior premolar to this species, I must now deny its existence in the adult animal. A slight fossa on the narrow alveolar ridge indicates the possible presence of a single-rooted rudiment of such a tooth in the young. In a comparison of this species with the *Auchenia weddellii* Gervais, from the Pampean beds of Buenos Ayres, it is readily observable that the latter is a true Auchenia, with well developed P-m. 3 in the upper jaw, and that it is of larger and more robust proportions than the *H. vitakeriana*. In the only well preserved lower jaw which I possess, there is a well developed P-m. iii, a tooth found only as an occasional accident in *Auchenia lama* (teste Owen Odontography). In the *A. intermedia* Gerv., from the same locality, this tooth is wanting from one ramus, while the other displays a shallow vacuity as though such a tooth had existed in infancy and had been shed. I therefore retain these species in Auchenia.

Holomeniscus hesternus Leidy. *Auchenia hesterna* Leidy, loc. sup. cit.

The existence of superior molars in the Museum Nacional of Mexico which agree with the corresponding teeth of the Californian and Oregonian llamas has been mentioned above. I give the dimensions of these teeth as follows :

Measurements.			M.
Diameters M. i		anteroposterior	.041
		transverse	.033
Diameters M. ii	one individual.	anteroposterior	.041
		transverse	.040
Diameter M. iii		anteroposterior	.053
		transverse	.029

* Bulletin of the U. S. Geological Survey Terrs., 1878, p. 380.

These molars are covered with a layer of cementum, which is included in the measurements.

The mandible, I am disposed to refer to a smaller variety of this species for the present. The well-worn fourth inferior premolar indicates that it could not belong to the genus Eschatius, where there is no opposing tooth in the superior series capable of producing such a result. The hook below the condyle is well developed in this jaw. The incisor teeth are narrow. The canine is small and is separated from the incisors by a diastema. The triturating surface of the fourth premolar is triangular, and includes a lake. The molars increase in size posteriorly. The mental foramen is large, and is situated behind a point below the canine.

Measurements.		M.
Length of jaw from incisive alveoli to angle		.415
Height at coronoid process		.290
" at condyle		.218
" ramus at M. i		.070
" " " middle of diastema		.040
Length of symphysis		.096
" from base of incisors to canine		.043
" " canine to P-m. iv		.092
" of all the molars		.147
Diameters P-m. iv	anteroposterior	.022
	transverse	.013
Diameters M. i	anteroposterior	.035
	transverse	.019
Diameters M. ii	anteroposterior	.042
	transverse	.019
Diameters M. iii	anteroposterior	.048
	transverse	.016

From Tequixquiac.

A cannon bone in Condon's collection, which may belong to this species, measures fifteen and a quarter inches in length. So far as the evidence goes it may as well have belonged to the *Eschatius conidens.* According to Leidy the cannon bone of the *Auchenia californica* Leidy measures nineteen inches in length. A cannon bone of at least this size, with other bones of the skeleton, occurs in the museum of the School of Mines, and may belong to the Californian species. Whether that species is a true Auchenia or not remains uncertain, as the teeth are unknown.

ESCHATIUS, gen. nov.

This genus is well characterized by the reduction of the fourth superior premolar to a simple cone, in place of the usual double crescent characteristic of the Ruminantia generally. This is the greatest known reduction of the premolar series in the Ruminantia, exceeding anything in the Bovidæ, a family otherwise more specialized than the Camelidæ. If my

identification of mandibles be correct, there is but one inferior premolar, which is not prismatic, but has two divergent roots as in Auchenia. The crown is compressed. In any case this genus is distinct from Palauchenia Owen, which is said to have the fourth inferior premolar composed of two crescents, somewhat as in the Protauchenia of Branco. There is also a simple conic third inferior premolar according to Owen. The type specimen of the type of Palauchenia, *P. magna* Owen, consists of isolated teeth put together in a bed of plaster of Paris. While there may be some uncertainty as to the position of the third premolar, I cannot agree with Professor Leidy* in the supposition that these teeth have been inverted by their describer, and really belong to the upper jaw. The specimen is preserved in the museum of the School of Mines, and I did not observe any second one.

ESCHATIUS CONIDENS, sp. nov.

Primarily established on a superior maxillary bone, which contains all its teeth, which is preserved in the Museum Nacional of Mexico. I cannot distinguish from this individual another one which was found by Mr. C. H. Sternberg in the desert of Oregon, and which is represented by a good many fragments, including parts of both jaws. I describe the Mexican specimen first.

The true molars increase rapidly in size posteriorly. The vertical ribs of the external anterior horns of the external crescents are very strong, and the external wall of the anterior crescent has a low rib on the median line also. The posterior internal crescent of the last superior molar (which is not much worn) sends its anterior horn to the external wall, thus cutting off the posterior horn of the anterior internal crescent.

Measurements.		M.
Length of the four superior molars		.126
" " M. i		.041
Diameters of M. ii	transverse at base	.024
	anteroposterior	.044
Length of M. iii		.051

The *foramen infraorbitale anterius* issues above the anterior rib of the posterior crescent of the first true molar. The specimen is from Tequixquiac.

The Oregon specimen includes a left maxillary and mandibular bones, with the roots or alveoli of the teeth remaining, together with numerous bones of the skeleton. As one or two teeth of the *Holomeniscus hesternus* are mingled with the other pieces, it becomes uncertain to which of the species some of the bones should be referred. This is the more difficult, as the superior molar teeth of the two animals are of nearly the same dimensions. The probabilities are, however, that the greater number accompany the species represented by the jaws. I proceed to describe the latter.

In the maxillary bone the single alveolus of the fourth premolar is close

* Report U. S. Geolog. Survey Te::rs. I, p. 256.

to that of the anterior root of the large first true molar. Its section is a wide oval. The base of the second true molar is not longer than that of the first true molar. The external wall of the maxillary bone is broken so that the position of the infraorbital foramen cannot be positively ascertained. A narrow groove, which may be a part of the infraorbital canal, is exposed, and is continued forwards to a point anterior to the first premolar, where it probably issues. If this be a correct inference, its position is anterior to that observed in the Mexican specimen. The palatine foramen issues opposite the anterior root of the first true molar. In the *Holomeniscus hesternus* this foramen issues opposite the fourth premolar's internal root.

The fragment of mandible is the anterior part of the left ramus, including the premolar and half the symphysis. The fundi of the anterior alveoli only are preserved. That of the canine is smaller than those of the incisor teeth, and is close to that of the external incisor. The mental foramen is large, and is situated posterior to the mouth of the alveolus of the canine. The symphysis is not coössified. The alveolar edge of the diastema is narrow, and presents a narrow vertical parapet outwards, which makes an angle with the external convex side of the ramus. The inferior outline below the diastema is a little concave. The roots of the premolar are well separated. The crown is lost. The coronoid process, supposed to belong to the same species, is like that of the llama, near the condyle, and is quite elevated. It maintains its anteroposterior width to near the summit. Anterior edge rounded, the bevel extending on the external face towards its base. The posterior rotula of the condyle is median, and not on one side as in the llama and in the camel. The anterior part of the face presents forwards as in the llama, and is not so much expanded as in the camel. The petrous bone is as large as that of the camel, and has a more widely open styloid fossa, which is directed more inwards in the downwards direction. The face also for the paroccipital process approaches much more nearly to its fundus than in either the camel or the llama.

Measurements.	M.
Long diameter of alveolus of superior P-m. iv	.009
" " " " M. i.	.036
" " " " M. ii	.038
" " " inferior P-m. iv	.022
Length of inferior postcanine diastema	.070
Depth of ramus at middle diastema	.035
" " P-m. iv	.045

It still remains to be ascertained whether this Oregon Eschatius belongs to the species that is found in the Pliocene beds of the valley of Mexico.

Eschatius longirostris, sp. nov.

This llama is known to me from a right mandibular ramus, which is broken off behind the last molar tooth, and which supports the symphyseal portion of the left ramus, less its external wall. In size this species is be-

tween the *Auchenia weddelli* Gerv. and the *Eschatius conidens*, having just about the dimensions of the *Camelus dromedarius* or the *Palauchenia magna* Ow. It differs from the *Eschatius conidens* in the much longer inferior diastema, longer, coössified symphysis, and smaller true molar teeth ; the comparison being made with superior molars of the *E. conidens.*

The alveolus of the inferior canine tooth is small, and is a short distance posterior to the third incisor, being separated by a short diastema. The mental foramen is very large, three times the size of that of the *E. conidens*, and its anterior edge is 20 mm. posterior to the canine alveolus. The alveolar parapet of the diastema is not so elevated as in *E. conidens*, but is distinct. The dentition shows that the animal is an old one. The fourth premolar has two divaricate roots, which spread nearly as far anteroposteriorly as those of the first true molar. The crown is compressed. Apex broken. The crowns of the molars are worn ; that of the first to the roots. The heel of the third true molar is lost.

Measurements.	M.
Width of mandible at inferior canines	.027
Length of inferior postcanine diastema	.110
" " molar series	.132
" " P-m. iv	.027
" " M. i	.029
" " M. ii	.034
Width of " M. ii	.022
Depth of ramus at middle diastema	.043
" " P-m. iv	.058

From the Oregon desert ; Professor Condon's collection.

BOS Linn.

Bos latifrons Harlan.

This species is represented by numerous remains, and must have been abundant in Mexico during the Pliocene epoch.

On the structure of the feet in the Extinct Artiodactyla of North America. By E. D. Cope.

(Read before the American Philosophical Society, August 15, 1884.)

The structure of the feet of a number of the Artiodactyles of the Tertiary beds of North America has already been described. In this paper I enumerate these, and add descriptions of some types which have been hitherto unknown. I commence with the Bunodonta.

Bunodonta.

Pantolestes Cope.

The structure of the tarsus only of this Eocene genus is known.*

* Cope, Proceedings American Philosophical Society, 1881, p. 188. Pal. Bulletin, No. 34.

The cuboid and navicular bones are distinct from each other and from the cuneïforms, and the ecto- and mesocuneïform are coössified. There are four metatarsals. The laterals (ii and v) are slender; and the medians are distinct but appressed, their adjacent sides being flattened. This foot structure is remarkably advanced considering the early age, Wasatch Eocene, of the period of its existence, and the primitive, tritubercular bunodont character of the superior dentition. The selenodont types which appear first in our series of formations, the Oreodontidæ of the White River low Miocene, present a much more primitive type of foot. The camel series is remarkable for the early and continued absence of the first and fifth metapodial bones. The first known of the line, Poëbrotherium, from the White River beds, has only minute rudiments of them. It is probable the Pantolestes, or some member of the Pantolestidæ, is an ancestor of Poëbrotherium, with a number of lost types intervening.

Elotherium Aym.

The first information respecting the structure of the feet of this genus was furnished by Marsh.* He says "The radius and ulna were separate or very loosely united. The third and fourth metacarpals were nearly equal in size, and the second and fifth longer than the corresponding bones of the pes. In the latter the first digit was wanting, and the fifth rudimentary." This description leaves us in the dark as to the development of the second digit in the posterior foot and of the second and fifth in the anterior foot. The ambiguous language led me to infer that there are four digits of the anterior foot of the animal described by Marsh, and hence to separate it generically from Elotherium. The first definite information is derived from Kowalevsky, from his great memoir on the genus Anthracotherium.† He here states distinctly that the genus is bidigitate, but with small rudiments of the second and fifth metapodial bones. He shows also that the lunar is equally supported by the magnum and unciforum. In a memoir especially devoted to this genus‡ he also shows that the cuboid, navicular and cuneïforms are distinct, while the ecto- and mesocuneïforms are coösified, the entocuneïform being absent. The structure of the tarsus in this genus is then as in Pantolestes, and from this genus or one of the same family, Elotherium no doubt took its origin through intermediate genera.‖

Selenodonta.

Oreodon Leidy.

We owe to Leidy the following statement regarding the foot structure of this genus.§ What are supposed to be the bones of the forearm and leg

* American Journal Sci. Arts, 1873, p. 487, June.

† Palæontographica, 1873, p. 188, August ?

‡ Loc. cit., xxii, N. F. II, 7, p. 415.

‖ I have given the structure of the anterior leg and foot in *Elotherium imperator*, Bulletin U. S. Geol. Surv. Terrs., Vol. v, p. 60.

§ Extinct Mammalia of Dakota and Nebraska, 1869, p. 72.

are discrete, as in the hog; and the bones of the feet correspond in number with those of this animal. In 1873, Professor Marsh confirmed these statements as regards the metacarpal bones,* and added "that the navicular and cuboid bones were loosely coösified or separate." In 1884† I gave a full account of the structure of the limbs in this genus. I mentioned a peculiar feature of the carpus, viz.: that the os lunare is supported below by the inward extension of the unciform, so that the magnum is below the scaphoideum. I also showed that the cuneïforms are distinct, and that the entocuneïform is wanting.

Eucrotaphus Leidy.

I have already stated that this genus is tetradactyle anteriorly and posteriorly.‡ I now add that the structure of the limbs and feet is in other respects like that of Oreodon. This is true of the inner extension of the unciform, so that the magnum is below the trapezoïdes. The inner side of the latter bone in the *Eucrotaphus pacificus*, is so excavated, that there was plainly a free trapezium of small size. In the posterior foot the entocuneïform is wanting, and the mesocuneïform is distinct from the ectocuneïform.

Merycochœrus Leidy.

The first information of the foot structure of this genus is contained in my paper on the Oreodontidæ above cited.‖ The fore and hind feet are there stated to be tetradactyle. I now add that in the *M. montanus* Cope, the os magnum is entirely below the scaphoid, and that there is a distinct trapezium. The posterior foot is constituted as in Eucrotaphus; I also observe that the navicular has a peculiar little facet on its distal face near the front of the external edge. This fits a corresponding facet which forms the proximal surface of a ledge, which extends from front to rear on the inner side of the cuboid. In *Eucrotaphus pacificus* the arrangement is similar, excepting that the ledge of the cuboid is interrupted at the middle by a deep excavation. In *Merychyus arenarum* the cuboid is like that of *Merycochœrus montanus* in regard to this ledge.

Merchyus Leidy.

The limbs and feet in this genus are quite as in Merycochœrus. The species which I have examined is the *M. arenarum* Cope.

Leptomeryx Leidy.

We possess as yet no information regarding the limbs and feet of this genus. It is therefore fortunate that I obtained in the White River bed of North Eastern Colorado, in 1879, a nearly entire skeleton of the *L. evansi* Leidy. The bones were all found close together, and belong to two individuals, and are without admixture of those of any other species.

* Amer. Jour. Sci. Arts, p. 409; Marsh does not credit Leidy with his previous observations.

† Proceeds. Amer. Philos. Society, Pal. Bulletin, No. 38, pp. 503—10.

‡ Loc. cit., p. 504.

‖ Proceeds. Amer. Philos. Society, 1884, p. 504.

From these, and inferentially from other specimens, is derived the curious fact, that there are four distinct metacarpals, all supporting digits, while there are but two metatarsals, which are coösified into a cannon bone. This diversity between the limbs is unparalleled, although an approach to such a condition is seen in the peccary. In this animal, as is well known, there are four distinct digits in the manus, while in the pes, the metatarsals are coössified proximally, and the fifth metatarsal is reduced to a scale. This difference between the two limbs is a further illustration of Mr. Ryder's statement that the posterior limb is in advance of the anterior in grade of development, for which I have endeavored to account by reference to the fact that it is the posterior foot which receives the greater number of impacts in progression. This is because the hind limb is the principal propeller of the body.

In accordance with the structure of the feet, the fore-limb is much behind the posterior limb in the fixity of its parts. The ulna and radius are distinct; the head of the latter a regular transverse oval. The distal extremity of the fibula is not coössified with the tibia, but forms a separate bone, as in the Ruminantia.

The lunar is mainly supported by the unciform, so much so that the front face of the magnum is not beveled to fit the former. Behind the face, the edge of the magnum is a little beveled for the lunar; but the former bone lies almost entirely under the scaphoid. The trapezoïdes is coössified with the magnum. No distinct trapezium.

The cuboid and navicular are solidly united. The ecto- and mesocuneïforms are distinct, and there is no entocuneïform. The second metatarsal is represented by a flat oval bone which is borne on the underside of the projecting heel of the third metatarsal. The fifth is of smaller size, and is a scale imbedded in a depression of the posterior part of the side of the fourth. Ungues unilateral, trihedral and acute.

Hypertragulus Cope.

Remains of this genus are as abundant in the White River beds as are those of Leptomeryx, and like that genus I know but the one species, the *H. calcaratus* Cope. Unfortunately I have not been able to obtain bones of the skeleton connected with dentition from this formation, although numerous bones occur separately which probably belong to it. The genus is however abundantly represented in the John Day Miocene beds of Oregon, where Leptomeryx does not probably occur. At least no specimens of the latter are to be found in a collection of between one and two hundred individuals of this general type in my collection. I cannot distinguish the John Day species from the *H. calcaratus*, although the size is generally distinctly larger.* In other cases the size is the same. To the John Day specimens then I refer for the characters of the feet of this genus.

* It is probably this species that is cited by Leidy as the *Leptomeryx evansi* in the Report U. S. Geol. Survey Terrs. I, p. 216.

The ulna and radius are coösified. The scaphoid and lunar facets of the radius are well distinguished by an oblique ridge. The carpus is unknown. The median metacarpals are separate; whether the second and fifth are well developed I do not know, but suspect them to be so, as in Leptomeryx, since the third and fourth bear no adherent rudiments. The cuboid and navicular bones are united, while the cuneïforms are distinct from them and from each other, as in Leptomeryx. There are but two developed metatarsals, and these are distinct from each other. Thus the fore-limb in its ulno-radius exhibits a little advance over Leptomeryx; while in the separate metatarsals it is behind the latter.

Hypisodus Cope.

This genus is remarkable for its prismatic dentition, being the only Artiodactyle presenting the character in the White River fauna.* It was probably well advanced in foot characters, but of these I know but little. Parts of two tarsi found with the jaws of the *H. minimus* Cope, are referred to the species on account of their very small size, and general correspondence. The cuboid and navicular are coössified. Their distal face, especially the navicular part, is so narrow transversely, that it is almost certain that the third and fourth metatarsals are coössified, and that the second and fifth are rudimental or wanting. There is no trace of facets for the latter on the naviculo-cuboid.

Poëbrotherium Leidy.

I have fully described the limbs of this genus in the Annual Report of the U. S. Geological Survey of the Territories for 1873†, as seen in the *P. vilsoni* Leidy, from the White River beds, and have confirmed them from a fine specimen of the *P. sternbergi* Cope, from the John Day or Middle Miocene of Oregon.‡ The characters are; ulna and radius coössified; trapezium and trapezoïdes present and distinct; magnum supporting part of lunar. Two distinct metacarpals, scales representing the second and fifth; navicular and cuboid bones distinct, as are the ecto- and mesocuneïforms; entocuneïform wanting. Metatarsals two, distinct; second and fifth represented by scales.

Observations on the Phylogeny.

I have maintained ‖ that the selenodont dentition is a derivative of the bunodont, a proposition which seems unavoidable from a mechanical point of view. The testimony of palæontology is also in its favor, since in America the oldest artiodactyle, Pantolestes, is bunodont. Kowalevsky in the phylogenetic table given in his monograph of Anthracotherium§ does

* See Cope, Annual Report U. S. Geological Survey Terrs., 1873, p. 501, where the cuboid and navicular are stated to be united.

† 1874, p. 499.

‡ Bulletin U. S Geol. Survey Terrs. V, p. 59.

‖ Journal Academy Natural Sciences, 1874. See also Ryder, The Mechanical Genesis of tooth forms, Proceeds. Academy Philada., 1879, p. 47.

§ 1873 (? 4), p. 152.

not commit himself as to this point, but allows the development of the two types of dentition to appear to have been cotemporary and from some common origin. He then derives from such a common point of departure first, the Hyopotamidæ, which first appear in the Eocene, and second, the ancestors of the Anoplotheriidæ. From the Hyopotamidæ he derives all the modern Selenodonta, exclusive of the Camelidæ. The latter group he omits from his table, doubtless because his information on the subject was insufficient. The main line of origin of the Selenodonta is divided early in Miocene time, the genus Gelocus giving origin to the Pecora, and the genus Hyæmoschus to the Tragulina.

In describing the characters of the genus Poëbrotherium for the first time, I remarked as follows :* "The present genus is a more generalized type than Gelocus, and in its distinct trapezoïd and distinct metacarpals represents an early stage in the developmental history of that genus. It also presents affinity to an earlier type than the Tragulidæ which sometimes have the divided metacarpals, but the trapezoïdes and magnum coössified. In fact Poëbrotherium as direct ancestor of the camels, indicates that the existing Ruminantia were derived from three lines represented by the genera Gelocus for the typical forms, Poëbrotherium for the camels and Hyæmoschus for the Tragulidæ."

These views being then established on sufficient evidence, it remains to make such additions as the facts cited in the present paper indicate. First in importance comes the place in the phylogeny of the Selenodonta, of the Oreodontidæ. The peculiar inward extension of the unciform bone already ascribed to them, characterizes also among extinct forms the genus Leptomeryx, and probably Hypertragulus. Among recent ruminants it is only seen in the Tragulidæ.† If we arrange these types in serial order we find the modifications of form to be generally identical with those of the other ruminant lines, in the coössification of the bones of the legs and feet. This series may then be regarded as phylogenetic. The peculiar structure of the carpus of the Oreodontidæ, puts them out of the question as ancestors of any type of existing ruminants other than the Tragulina. Whether they themselves can be traced to a five-lobed, or to a four-lobed bunodont ancestor, remains an undecided question. It is not, however, probable that a five-lobed form has been intercalated in a series, both of whose extremities are four-lobed. If this be true, the Oreodontidæ must be regarded as an ancestral type of Selenodonta, coëqual with the Hyopotamidæ, and it may well be questioned whether the latter can have been ancestors of the existing Ruminantia, whose molars are four-lobed.

So the present investigation does not disclose the ancestral stock of the Pecora. In North America we have not progressed further in the solution of this question than I reached in 1877,‡ after a study of the genera

* Bulletin U. S. Geol. Survey Terrs. Vol. i, No. 1, p. 26, Jan., 1874.

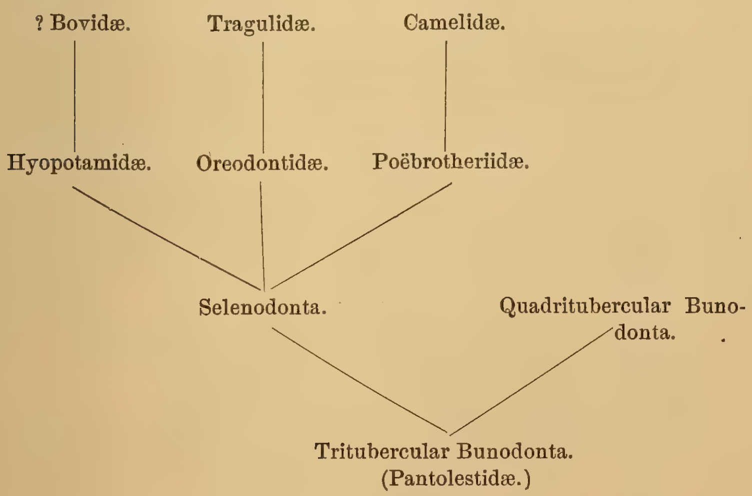
† Among Perissodactyles it occurs in Triplopus, Tapirus and the Rhinocerontidæ.

‡ Proceedings Amer. Philos. Soc., p. 223.

Cosoryx Leidy, and Blastomeryx Cope. I had already* suggested that the former genus is the ancestor of the Cervidæ, but subsequently† remarked : "It is not probable this genus is the immediate ancestor of Cervus, from the fact that the molar teeth display in their prismatic form a higher degree of specialization than belongs to that genus. It is probable that the true ancestor combined the dental type of Cervus with the distinct roots and short crowns of the molars, with the type of horns here described." I at that time included a species (*Cosoryx gemmifer* Cope) in the genus, provisionally, which has the type of molars in question. Having discovered another, larger species, which has the same type of molars, I at once distinguished the provisional group in which I had placed the *C. gemmifer*, Blastomeryx, as a genus ; and in describing the species (*B. borealis*) observed as follows :

"In brief, its molars differ from those of Cosoryx ("Dicrocerus") much as those of the deer differ from the molars of the antelope. While Cosoryx ("Dicrocerus") was probably the ancestor of Antilocapra, Blastomeryx was the ancestor of Cervus or Cariacus." This opinion expresses all the information I possess on the subject at present. It remains to ascertain the structure of the anterior feet in Hypisodus, which is the earliest genus of Ruminantia known to have prismatic molars.

The following table will represent the views expressed in the preceding pages :



* Proceedings Academy Philadelphia, 1874, p. 149.

† Report Expl. Surv. W. of 100th Mer. U. S., G. M. Wheeler in charge, iv, pt. ii, p. 349, 1877.

*Fifth Contribution to the Knowledge of the Fauna of the Permian Formation of Texas and the Indian Territory. By E. D. Cope.**

(Read before the American Philosophical Society, August 15, 1884.)

PISCES.

CERATODUS FAVOSUS, sp. nov.

This species is known to me from a piece of the lower jaw, which supports a tooth. One extremity of the tooth is broken off, but from the curvature of its inner side, it is to be inferred that the portion lost is but small, probably including one of the three processes which the tooth possesses. The species may be distinguished from those described by Agassiz, and from the existing species, by the great depth of the two emarginations of the external side. These enter the crown so deeply as reduce its width to dimensions no greater than those of each of the processes of the crown. The internal face is strongly convex, and one extremity is more strongly recurved than the other. The crown consists of a mass of coarse perpendicular simple calciferous tubules, which are enclosed in a rather thin layer of a dense substance which thickens downwards, and laps over the external face of the jaw bone. The external surface of this layer is vitreous. The walls of the tubules are of a dense and hard substance, of a darker color in the fossil, and the tubules are filled with a softer substance, so that the grinding surface of the crown has the appearance of a small honeycomb. The diameter of the tubules ranges from 1. to .05 mm. The fragment of jaw is robust, is deeper than wide, and is strongly convex on the internal face. The internal inferior angle rises at one extremity above the level of the external inferior angle. The processes of the crown project freely beyond the bone, having rested on the cartilage which forms the external face of the jaw, as Günther has shown to be the case in the *C. forsteri.*

Besides the deep emarginations of the crown, the coarseness of the calciferous tubules is a special character of this species.

Measurements.	M.
Depth of jaw with tooth	.019
" " without tooth	.012
Width of crown at middle process	.014
Probable length of crown	.022

Found by Mr. W. F. Cummins.

Agassiz did not record any species of this genus from below the Trias, but Fritsch has reported them from the Permian of Bohemia.

BATRACHIA.

CRICOTUS CRASSIDISCUS, sp. nov.

Accession of additional material enables me to add several points to the

* The "Fourth Contribution" will be found at page 628 of these Proceedings for the year 1883.

knowledge of the osteology of this genus, and to distinguish satisfactorily three species. I have much pleasure in obtaining these additional facts, since everything relating to this curious genus is of interest.

In the first place, the neural arches are not coössified to the centra, but are readily separated from them. Their basis of attachment forms, on each side of the median neural canal, an oblique triangular surface looking forwards and upwards, with the apex above and behind. The ease with which the neural arches separate accounts for the rarity of their occurrence on separate centra. They support the diapophyses at their lower border. Second, that the sacrum consists only of a centrum and an intercentrum, both of which take part in furnishing a concave facet for the attachment of the pelvis. Third, some of the ribs are two-headed, and their capitular articulation is with the posterior edge of the intercentrum. Fourth, there is a hyposphenal articulation, as in the genera of Jurassic Saurians, Camarasaurus, Amphicœlias, etc., and in the Permian genus Empedias, among the Theromorpha. The hypantrum has, however, this peculiarity : that its sides are produced forwards into a process on each side below the prezygapophyses, each of which is subconical in form, but with the interior face excavated to receive the hyposphen, so that the section of the process is crescentic. These processes I have never previously observed. I call them hypantrapophyses. I find them in the *Cricotus hypantricus*. The neural arches of the other species are either lost or in such close juxtaposition that I cannot see them.

The species differ in part as follows ; the full characters can only be given in more detailed descriptions of more perfect specimens.

I. Dorsal intercentra much narrowed or pinched above.
Hypantrum unknown.......................................*C. heteroclitus.*

II. Dorsal intercentra equally robust above as below, or more so.
Hypantrum unknown.......................................*C. crassidiscus.*
Hypantrum with acute lateral processes...................*C. hypantricus.*

The measurements of the *C. crassidiscus* are as follows :

Measurements.			M.
Diameters of dorsal centrum behind	vertical		.025
	transverse		.025
Length of do.	middle line below		.013
	at base of neural arch		.013
Base of neural arch	width		.010
	length		.009
Diameters of a dorsal intercentrum	vertical		.025
	transverse		.025
Length of do.	middle line below		.009
	" " above		.0095
Diameters of coracoid	transverse length		.027
	width	at glenoid face	.029
		at internal face	.010

It is probably this species which I have figured in the Proceedings of the American Philosophical Society,* and American Naturalist,† under the name of *C. heteroclitus.* It is the most abundantly represented in my collection. In the specimen figured in the American Naturalist, the probable scapula is visible on both sides, but the coracoid is concealed by the pectoral scuta.

CRICOTUS HYPANTRICUS, sp. nov.

This Embolomere is probably represented by two individuals, which are of larger size than any species which have hitherto come under my notice, one of them very much larger. It is only the smaller specimen which is accompanied by the astragalus. Both of them display the hypantrapophyses already mentioned in remarks on the genus under the head of *C. crassidicus.*

As already pointed out in the key of species, the dorsal intercentra in the *C. hypantricus* are stout and not narrow above, but the thickness increases rather than diminishes upwards. They thus differ from the corresponding intercentra in the *C. heteroclitus.* In many of the dorsal intercentra the dense external layer which covers the inferior face continues upwards to an apex, the articular surfaces of the two ends meeting so as to exclude the former. This is also the case in the *C. crassidiscus.* The centra have the abbreviated form characteristic of the genus, and the foramen chordæ dorsalis is present, but is smaller than the *C. heteroclitus.*

The supposed astragalus is oblong ; proximal‡ border longer than the distal, which is separated by an obtuse angle from the ectad ; distal entad not reaching superior surface of bone, long, extending inwards below the revolute proximal part of the entad face, from which it is separated by a narrow oblique groove. Proximal and distal entad separated by notches of the two faces ; a ridge the length of the bone below.

Measurements.		M.
Diameters of centrum of individual with astragalus.	anterposterior	.015
	transverse	028
Diameters of astragalus	anterposterior	.038
	transverse	.029
Diameters of centrum of larger individual.	anteroposterior	.018
	transverse	.038
Diameters adjacent intercentrum of do.	anteroposterior	.013
	transverse	.038

REPTILIA.

CLEPSYDROPS LEPTOCEPHALUS, sp. nov.

This species is represented by almost the entire skeleton, the principal deficiency being that of the scapular arch and the anterior limbs, with the

* 1881, pl. ii, figs. *a–b.*

† 1884, p. 39, pl. v and fig. 7. In pl. v, figs *f* and *g* represent the *C. heteroclitus.*

‡ I determine the ends of this specimen from a foot of Eryops.

phalanges of the posterior feet. The bones of the skull are mostly preserved, but in a dislocated condition. They serve to demonstrate some of the characters of the genus and family.

The quadrate bones of both sides are distinctly displayed. They are rather short, and articulate above by squamosal suture with the squamosal bones, which overlap them posteriorly. They narrow upwards, and are deeply grooved on the anterior face below. Each edge of the groove is produced forwards; the external for a considerable distance as an acuminate laminiform process, in the usual position of a quadratojugal bone. The production of the internal edge is shorter, and its extremity is vertically truncate. Its superior edge fits an incurvature of the superior edge of the pterygoid bone, and its internal face is applied to the external face of the latter.

The pterygoid bone displays the subtriangular plate with dentigerous edges, such as I have already described as present in the species of Dimetrodon. In this species it is thinner and less massive than in any species of that genus yet known. This specimen enables me to locate it more precisely than heretofore. The pterygoids were probably placed much as I have represented them to be, in the *Empedias molaris* Cope (Proceedings American Philosoph. Society, vol. xix, p. 56, pl. v). They send inwards a subtriangular plate from each side, which approach each other on the median line without touching, and the adjacent edges are somewhat decurved. The posterior edges are deeply concave on each side of the middle line, and like the inferior edges, are dentigerous. The process for the quadrate extends outwards and backwards, and is thickened on its posterior edge, while its anterior edge, which is continued from the inferior edge of the posterior border, becomes very thin. The anterior production for the ectopterygoids extends outwards and forwards, leaving the anterior edge of the dentigerous plates as the concave posterior border of the large palatine foramina. The anterior production of the internal edge of the plate becomes very thin, and is broken in the specimen without showing articulation for the palatine.

The squamosal extends both above and below its anteriorly directed zygomatic portion. The superior extremity shows squamosal suture for the parietal.

The stapes is of large size. It consists of a stout rod terminating in a double extremity, something like the double head of a rib. The shorter head is expanded into a funnel shape. Near to it the shaft is perforated in the longer diameter by a foramen. The extremity of the other head is transversely truncate and is separated from the funnel by a deep notch. On the outer side of the fundus of this notch, a foramen penetrates the shaft obliquely and is continued into a canal which issues at the foramen first described. The distal end is truncated by an irregular sutural surface. In the specimen the bone lies behind the squamosal and quadrate bones, the simple extremity of the rod near the posterior edge of the quadrate.

The premaxillary bones are distinct. The teeth of that bone and of the maxillary are of unequal sizes.

The axis has an expanded neural spine, and a diapophysis for rib articulation, but no parapophysis or capitular fossa. The two latter features characterize all the vertebræ which follow, as far as the lumbar series.

The column in the typical specimen is tolerably complete, with a break of uncertain, but probably not great length in front of the sacrum, and the loss of the distal part of the caudal series. Intercentra of rather small size are present throughout the series anterior to the sacrum. The inferior faces of the caudal vertebræ are yet concealed by matrix. The bases of the neural spines are compressed ; they were probably not elongate as in Dimetrodon, though they are unfortunately broken off, except that of the third cervicodorsal vertebra. Here the spine is short and truncate above, and rather wide anteroposteriorly. As in Dimetrodon there is no distinction between cervical and dorsal vertebræ.

The pelvis is well preserved, and has the characters already assigned to the *C. natalis* Cope.* The ilium has a process or narrowed continuation with parallel sides, directed backwards and upwards, and bearing a keel on the middle line on the internal side. The ischia are much produced posteriorly, and are separated by a notch on the middle line posteriorly.

The head of the femur is expanded, including probably the homologue of the great trochanter of mammalia, and its articular face is crescentic, with obtuse horns. There is a trochanter below it on the posterior edge of the shaft. The condyles are inferior, and are separated by a deep groove above and a shallow one below. The articular faces of the two condyles are continuous, forming and ∞-shaped figure. The proximal extremity of the tibia is wider than the distal, and the articular face is uninterrupted. That of the distal extremity is a transverse oval.

Specific characters. While the vertebral centra of this species are rather short, the bones of the head are very much attenuated, and the jaws are long and slender. None of the four jaws is prefectly preserved, but the number of the teeth in the maxillary bone may be approximately fixed at thirty in a continuous series. One, and probably two of these, placed near the anterior part of the series, are larger than the others. They are placed at the position of the corresponding large maxillary teeth in Dimetrodon, but they do not display the dimensions seen in the species of that genus. To strengthen the jaw at this point, a rib rises from the thickened alveolar portion, and extends vertically on the inner side of the thin facial plate of the bone. The facial plate is double, and each lamina, except at the rib, is not thicker than wrapping paper.

The premaxillary bones are robust, and are excavated postero-laterally for a very large nostril on each side. The spine is long. The alveolar edge bears five teeth, which are followed by a diastema. These diminish in size posteriorly, the first one being the largest, and equaling the large

* Proceeds. Amer. Philos. Society, 1878, p. 509.

maxillary teeth. The last two are quite small, less than the usual maxillary teeth.

The dentary bones are very slender, and the distal end is somewhat thickened to support two teeth larger than the others. These are the third and fourth from the extremity, and are not quite so large as the large teeth of the maxillary bone. The remaining mandibular teeth are small, and are not so much compressed as in the species of Dimetrodon. Many of them have only a posterior cutting edge, which is not denticulate. The apices are strongly turned backwards in the posterior part of the series. The posterior part of the dentary bone rises and carries some of the teeth with it.

The surface of the free edge of the internal plate of the pterygoid bone is granular. The teeth on the posterior edge of the same are subconic, and in a single series.

There are twenty-seven vertebræ in a continuous series, from and including the axis. All bear diapophyses, and all are rib-bearing, except perhaps the last two, where they are of reduced size. They are more or less opposite the neural canal as far as the twenty-second centrum. On this vertebra the superior edge is on a level with floor of the canal, and posterior to this point the diapophyses rise from the centrum. Two sacrals and ten caudals are preserved, and all have diapophyses and neural spines. The centra in this species are rather short, being as deep as long throughout the series, if measured at the middle. The edges are not undulate as in *C.* (*Embolophorus*) *limbatus* Cope. The intercentra are short and not extended upwards on the sides as in that species.

Measurements.	M.
Length of quadrate bone	.085
Width of condyle of quadrate bone (greatest)	.037
Length from condyle of internal anterior process of do.	.032
“ “ “ external “ “ “	.097
“ of squamosal bone (vertical)	.124
“ “ pterygoid from palatal foramen	.116
Width “ “ at middle	.090
Length “ internal dentigerous edge of do	.070
“ “ posterior “ “ “	.051
“ “ maxillary bone posterior to canine brace	.181
Thickness of “ “ at canine brace	.020
Depth of “ “ “ nostril	.016
Length of premaxillary bone (posterior apex restored)	.060
Width “ “ “ at third tooth	.022
Diameter of large (first) premaxillary tooth	.008
“ “ “ maxillary tooth (canine)	.009
“ “ small “ “	.006
Length of crown of last maxillary tooth	.009
“ “ twenty-seven continuous cervico-dorsal vertebræ	.855

Measurements.			M.
Length of two sacrals			.65
" " ten caudals			.260
Diameters centrum axis	anteroposterior		.034
	vertical posteriorly		.031
	transverse posteriorly		.030
Elevation of neural spine from centrum			.071
" " arch " "			.009
Width of postzygapophyses			.030
Elevation of neural spine of fourth vertebra			.058
Diameters centrum sixteenth vertebra	anteroposterior		.025
	vertical at end		.035
Diameters end centrum seventeenth centrum	vertical		.034
	transverse		.030
Expanse of postzygapophyses of seventeeth vertebra			.029
Diameters twentieth centrum	vertical at end		.031
	anteroposterior		.027
Diameters of twenty-ninth centrum	anteroposterior		.024
	transverse behind		.035
Expanse of postzygapophyses of twenty-ninth vertebra			.024
Width of sacrum through fixed diapophyses			.049
Diameters centrum twentieth caudal	anteroposterior		.025
	vertical behind		.0265
	transverse "		.0225
Expanse through diapophyses			.047
Elevation of prezygapophyses (greatest)			.039
Diameters of pelvis	anteroposterior (apex of pubis restored)		.235
	vertical through acetabulum		.123
Anteroposterior diameter of ilium at acetabulum			.089
Depth of ischium at posterior edge of acetabulum			.080
Length of " from acetabulum			.117
Length of femur			.179
Proximal diameter of femur	anteroposterior		.075
	transverse (at middle)		.025
Diameters shaft at middle	transverse		.038
	anteroposterior		.031
Diameters of distal end	transverse		.068
	anteroposterior	external condyle	.031
		internal "	.045
Length of tibia			.150
Diameters of tibia	proximal	anteroposterior (middle)	.040
		transverse	.057
	median	anteroposterior	.019
	distal	anteroposterior	.026
		transverse	.041

The typical specimen of this species was found by Mr. W. F. Cummins in the Permian beds of Northern Texas.

Clepsydrops macrospondylus, sp. nov.

This species, like the last, much exceeds the *C. natalis* in dimensions. The bases of the neural spines are enlarged, so that it is probable that the spines were not elongate as in the species of Dimetrodon. Intercentra are present throughout the dorsal and caudal series of vertebræ. The dentary bone supports one or two large teeth near the extremity. These characters furnish the reasons for referring the species to the genus Clepsydrops.

The individual by which the species is known, is represented by an axis vertebra, twelve continuous dorsal vertebræ; nine other continuous vertebræ, of which three are lumbar, two sacral, and four caudal. Also by a part of the ilium, and by the greater part of a dentary bone. All of these specimens were found together, and possess an identical mineral appearance.

That this reptile belongs to a distinct species from the *C. leptocephalus* is readily determined by the form of the dorsal vertebræ. The centra are a little longer than those of that species, but have a smaller vertical diameter. The latter is three-fifths of the former, while in the *C. leptocephalus* the two dimensions are reversed, the depth being a little in excess in corresponding parts of the column. The dentary bone, on the contrary, is more robust than that of the *C. leptocephalus*, and supports, probably, a small number of teeth.

The edges of the centra are not undulate or laterally flared. The centra are strongly compressed, and in the anterior part of the column have an obtuse hypopophysial keel. The intercentra display equal width of the inferior surface; and are abruptly rounded at the extremities. The last one preserved is between the second and third caudal centra. It is shorter and wider than the others, and does not display any trace of a chevron bone. The diapophyses are opposite the neural canal on the thirteen anterior vertebræ preserved. Each one sends a horizontal rib forwards to the prezygapophysis, and another obliquely forwards and downwards which stops short of the edge of the centrum. These ribs enclose a fossa in front of the diapophysis. Posteriorly the anteroinferior rib grows more robust, and evidently supports part of the tuberculum of the rib. There is no facet for the capitulum until the antepenultimate vertebra of the anterior series is reached. Here and on the penultimate the anterior border is flattened into a facet, and on the last of the series, the facet marks the summit of a distinct tuberosity, which is produced by the cutting away of the border below it, to accommodate the intercentrum.

The three lumbar vertebræ preserved are different from the dorsals in their greater abbreviation. This character is not unknown in other species of Pelycosauria. The centrum is contracted, but not compressed, at the middle. The diapophysis is altogether on the centrum, and supports no rib-facet. Its anteroinferior buttress is well developed, extending to the

margin of the centrum which is cut out below it for the intercentrum. The sacrum is rather robust. Its two vertebræ are not coössified, and support well developed neural spines, and a large free diapophysis for the ilium. The centra of the caudals, and their diapophyses and neural spines are well developed. There is a fossa at the base of the spine on each side, in line with the zygapophysial surfaces, equidistant between them.

The fragment of ilium is of appropriate size, and is quite robust. It displays the fossa for the sacral diapophysis, and the acetabulum. The latter is remarkable for the prominence of the tuberosity on the superior border, which exceeds that of any species of Pelycosaurian known to me. The section of the ilium through it is triangular.

The dentary bone is accompanied by the splenial to the middle of the symphysis. The latter is not very long. Its dentary portion turns upwards. The ramus is quite robust, differing much from that of the *C. leptocephalus*. It is broken off a little anterior to the tooth line, but the latter probably did not contain more than twenty-two teeth. These have anterior and posterior cutting edges, and are denticulate. The external face of the dentary is excavated by shallow, undulating, branching grooves.

Measurements.

			M.
Total length of vertebræ preserved			.640
Diameters centrum of a dorsal vertebra	anteroposterior		.031
	vertical behind diapophysis		.019
	transverse	at end	.021
		at middle	.0115
Diameters neural arch of same vertebra	length with zygapophyses		.041
	width at prezygapophyses		.022
Diameters neural spine of same vertebra	anteroposterior		.0145
	transverse behind		.007
Diameter of intercentrum of do	anteroposterior		.0052
	transverse		.023
Diameters of a lumbar centrum	anteroposterior		.024
	transverse at end		.026
	" " middle		.023
	vertical behind arch		.022
	" at end		.029
Length of sacrum			.055
Diameters of third caudal vertebra	anteroposterior		.024
	vertical at end		.023
	transverse at end		.022
Anteroposterior diameter of acetabulum			.0325
Transverse diameter of ilium at tuberosity			.0265
Length of dentary bone supporting twenty teeth			.044
Thickness at twentieth tooth			.0175
Depth ramus at second tooth			.035
" " " fifteenth tooth			.039

The bones of this specimen are in excellent preservation. They were recovered by Mr. W. F. Cummins from the Peruvian beds of Texas.

EDAPHOSAURUS MICRODUS, sp. nov.

The genus Edaphosaurus Cope, was established on the *E. pogonias* Cope (Proceed. Amer. Philos. Soc., 1882, p. 448), which is represented by a specimen, which includes only a distorted cranium, with most of the parts preserved. The present species is represented by an individual of which I possess numerous vertebræ and ribs, and the dentigerous plates of both jaws. These are part of the dentary splenial in the inferior jaw, and the pterygoid or palatine of the superior. The specimen enables me to determine the characters of part of the vertebral column in the genus Edaphosaurus.

In the first place the vertebræ possess enormously elongate neural spines, as in Dimetrodon. Next, the centra have a facet on the anterior edge above the middle for the head of the rib, as in a mammal. It is not repeated on the posterior edge of any of the thirteen centra preserved. Thirdly, the ribs are only compressed proximally. Distally their section is a wide oval. The extremity is truncate and concave. The shaft is hollow, the walls being thinnest distally.

Specific characters. The grinding teeth of this species are about as numerous as in the *E. pogonias*, there being about seven in a transverse row on each plate. They are, however, less closely placed than in the typical species, and have more conic crowns. They do not form a pavement, as they are separated by wider interspaces.

The centra are rather elongate, and the *foramen chordæ dorsalis* is rather large. No intercentra are preserved, and if present they must have been very small, as the inferior rim of the centrum is not beveled to receive one. The neural spines have transverse processes which commence near the base, and project at intervals from the sides. The inferior ones are oval or subround in section ; those which succeed are more or less compressed. The extremities are enlarged fore and aft so as to be claviform in outline, but are compressed except where thickened by lateral tuberosities. These are rarely symmetrical, one being larger and situated higher up, sometimes giving the apex an unsymmetrically bilobate form. Sometimes they project at right angles to the terminal expansion. The shaft of the spine has a rather small medullary cavity, and this issues by an open mouth at the summit of the apex without constriction. This peculiar arrangement suggests a cartilaginous continuation of the spine which retains the nutritive artery of the medullary cavity. The anterior face of the shaft is grooved from the base for some distance upwards ; the posterior face is plane and then rounded above.

Measurements.		M.
Diameters of inferior dental patch	anteroposterior....	.043
	transverse........	.024

Measurements.

			M.
Diameters of a posterior dorsal centrum	anteroposterior		.0335
	vertical at end		.027
	transverse	at end	.026
		at middle	.015
Measurements of piece of spine of same	length		.132
	diameter at base	anteroposterior	.023
		transverse	.019
Diameters of median dorsal	vertical	at end	.032
		behind arch	.025
	anteroposterior		.0465
	transverse	at end, at flare	.037
		at middle	.016
Diameters of summit of spine	anteroposterior		.032
	transverse		.032

The ramous character of the neural spines of this species is much like what is seen in the *Dimetrodon cruciger* Cope. The rami in this species, however, retain their size upwards, and become compressed, a feature not seen in the *D. cruciger*. The apices of the spines in the latter species are not dilated as in the *E. microdus*.

Found by W. F. Cummins in the Permian beds of Texas.

THE POSTERIOR FOOT IN PELYCOSAURIA.—The foot-bones of the reptiles of the suborder Pelycosauria are abundant in the collections from the Permian formation, and I have examined my collection for specimens in which they are in normal connection, for the purpose of identifying them. I have been so fortunate as to find an entire tarsus, with the proximal parts of the metatarsi, in the skeleton which served as the type of my description of *Clepsydrops natalis*.* The characters presented by this foot are no doubt present in all of the Clepsydropidæ, which includes the genera Theropleura, Dimetrodon, Embolophorus, and probably others. Tarsal bones identical with those of the *C. natalis* were found with the original specimens of *C. collettii* and others of much larger size, accompany remains of species of Dimetrodon, or Embolophorus.

The astragalus and calcaneum are large and well specialized bones, distinct from each other and from the other tarsal elements. They do not resemble the corresponding bones of any known type of vertebrate, as will presently appear. The navicular bone is distinct, and the cuboid apparently consists of a single element. This depends on the interpretation given to a small bone on its posterior face, which is broken on its free edge, and may be the head of the fifth metatarsus. There are three elements in contact with the distal face of the navicular, which correspond with the three mammalian cuneïforms. The space available for this contact seems hardly sufficient for the three elements present, one of which is out of position and on the inferior side of the carpus. This element

* Proceedings American Philosoph. Society, 1879, 509.

looks also from its free inferior side like an ungual phalange, but is flatter than is characteristic of this family. There are three metatarsals distal to the navicular, which are well accommodated with articular facets on the distal extremities of the three bones in question, so that their identification as the three cuneïforms, is probably necessary. The two remaining metatarsals are articulated, the fourth to the exterodistal facet of the cuboid; and the fifth to the exterior side of the cuboid. The third, fourth and fifth metatarsals are directed at an obtuse angle posteriorly from the long axis of the astragalus.

This structure is more mammalian than any form of foot yet known among reptiles, and agrees with the indications of mammalian character described as existing in the long bones of the limbs by Owen and by myself.

The astragalus is an oblong bone with one long straight side, viz., that which is in contact with the calcaneum. This side has two facets for articulation with the calcaneum, which are separated by a groove, which forms a foramen when the two bones are in place. The proximal extremity of the bone is much smaller than the distal, and is subround. The proximal half of the bone would be nearly cylindric were it not for the truncation caused by the calcaneal facet. The distal half of the bone is robust, and is surrounded on all sides by facets. These are the external or calcaneal, the distal or navicular, and the internal which is larger than the other two together. The first two are oblong and truncate, the navicular twice as large as the calcaneal, its transvere much exceeding its anteroposterior diameter. The internal facet already mentioned, covers the internal face of the distal half of the astragalus, which projects further inwards than the proximal half, rising abruptly from it. The facet is continuous with the navicular, and is at right angles to its plane. It widens proximally, and its proximal border is deeply notched. Its surface is convex from back to front, but not strongly so. In the astragalus of a species of Dimetrodon, it is divided by an angle into two facets, the two faces thus produced being nearly at right angles to each other. This inferior part of the facet is continued into a prominent border which is more or less roughened. A rounded tuberosity of the inferior face of the bone occupies the space between this border and the calcaneal border, so approaching the notch already described, as to cause a groove to proceed from it posteriorly and inwards. I described the corresponding bone in the *Clepsydrops collettii* (Proceeds. Phila. Academy, 1875, p. 409) as a possible coracoid.

The calcaneum has its postero-external edge broken in the specimen of *Clepsydrops natalis* described, but is probably a semidiscoid bone, with its straight margin applied to the astragalus. This margin presents a median flat elongate-oval facet, which is separated by grooves from a facet at each end. The proximal facet is the narrower, and passes by a curve into the proximal extremital facet, which is adjacent to the corresponding proximal facet of the astragalus. The distal internal facet is triangular and wider

than long, and is separated by an angle only from the distal facet. The latter is a little more than a half circle in outline, and joins one bone of the second row, which I suppose to be the cuboid. The fact that it does not articulate with the second element in that row, leads me to suspect that the latter is the head of a fifth metatarsal. The external edge of the bone thins out more rapidly at the distal than at the proximal extremity.

The cuboid bone is pentagonal in outline, and square in transvere section. It is not unlike that of the Amblypodous Mammalia. It has a transverse proximal facet, and two distal ones which meet at an angle about right. The fifth metatarsal is articulated with its posterior face; and the fourth with the exterior distal face. The ectocuneïform articulates with the interior distal face. The navicular bone is subtriangular in transverse section, and with a subquadrate base articulating with the cuboid. Its longitudinal and anteroposterior diameters are about equal. The distal or metatarsal articulation of the entocuneïform is transverse and flat.

The manner of articulation of the ankle-joint must have been different from the usual reptilian type. The proximal extremities of the astragalus and calcaneum combined are not too large to have received the distal extremity of the fibula, so that the tibial articulation must be sought elsewhere. This may have been on the large distal facet of the anterior or inner face of the bone. A part of this facet looks upwards and probably supported the tibia, which was thus removed by a short space from that of the fibula. The down-looking part of the facet, which is more distinct in Embolophorus, must have articulated with a separate element. This may have been a spur, such as exists in the known genera of the Monotremata; as the position is identical with that which bears this appendage in those animals. It is quite evident that an element additional to those known in the ordinary reptilian foot exists in the Clepsydropidæ.

The separation of the distal extremities of the tibia and fibula is not usual among reptiles, but it is common in the salamanders, where the os centrale comes between them. It is also evident that the subcylindric proximal part of the astragalus, which intervenes between the supposed tibial and fibular articulations, represents that bone.

The metatarsals are directed obliquely backwards as well as outwards, as in Tachyglossus and Platypus.

The following results may be derived from the preceding statements: (1) The relations and number of the bones of the posterior foot are those of the Mammalia much more than those of the Reptilia. (2) The relations of the astragalus and calcaneum to each other are as in the Monotreme *Platypus anatinus*. (3) The articulation of the fibula with both calcaneum and astragalus is as in the Monotreme order of mammals. (4) The separate articulation of the anterior part of the astragalus with the tibia is as in the same order. (5) The presence of a facet for an articulation of a spur is as in the same order. (6) The posterior-exterior direction of the digits is as in the known species of Monotremata.

Thus the characters of the posterior foot of the Pelycosauria confirm the

evidences of Monotreme affinity observed by Professor Owen and myself in the bones of the legs, especially of the anterior leg. It remains a fact that with this resemblance in the leg there is a general adherence to the reptilian type in the structure of the skull. But this adherence is not so exclusive as has been supposed, as I will now endeavor to show.

THE STRUCTURE OF THE COLUMELLA AURIS IN CLEPSYDROPS LEPTOCEPHALUS.—As already briefly described above, this element is bifurcate at the proximal extremity. The shorter expanded extremity is the stapes proper. The oblique perforation of its base is a character which has not been hitherto observed in any reptile, not even in the allied form Hatteria (Huxley). If, as is probable, the perforation is homologous with the foramen of the mammalian stapes, we have here another point of resemblance to this class. The longer proximal branch of the columella has only half the width of the stapedial portion, and its long axis makes an obtuse angle with that of the latter. It is perhaps the ossified suprastapedial cartilage of Huxley, which that author states (Anatomy of Vertebrated Animals, p. 77) is not ossified in any of the living Sauropsida. Huxley supposes this cartilage to be the homologue of the incus, and remarks * that in a young Mammalian fœtus "it appears exactly as if the incus were the proximal end of the cartilage of the first visceral arch." The columella now described resembles a rib, of which the suprastapedial process resembles the head, and the stapes the tubercle. If this process be the incus, the stapes is shortened as in the majority of Mammalia, unless the primitive suture between the two be longitudinal. The form and position of the true stapes give support to the view of Salensky, that it is not part of a true visceral arch, but is developed in the connective tissue surrounding the mandibular artery. We see that in this Pelycosaurian it is not the proximal part of the arch, and surrounds the mandibular artery. The columella is divided into at least two distinct elements. This is clearly indicated by its abrupt truncation distally by a rough sutural surface. If there is but one bone distad to the stapes, it is homologous with the cartilage, which has been shown by Peters † to be distinct in Hatteria, crocodiles and various lizards. It is the triangular ligament of Cuvier. If the suprastapedial be incus, this element is malleus; and it is usually identified as such by the older anatomists. In this structure we have evidence that the hypothesis that the articular and quadrate bones are homologous with the ossicula auditus is incorrect. The Pelycosauria will probably come under the head of "Sauropsides malleoferes" of Albrecht. We have here an approximation to the Mammalia in two points: (1) The perforation of the head of the stapes; (2) and the ossification of the incus, which (3) is distinct from the malleus, thus furnishing homologues of the principal ossicles of the ear. It

* Proceedings Zool. Society, London, 1869, p. 391.

† Monatsberichte der Academie Sciences, Berlin 1868 (p. 592)—1870.

is unnecessary to observe however, that this part of the skeleton does not resemble the corresponding part in the known Monotremes.

Structure of the quadrate bone in the genus Clepsydrops.—The quadrate bone in *Clepsydrops leptocephalus* Cope, already described, is of highly interesting form. It consists of two portions, a vertical and a transverse, the latter much longer than the former. The vertical portion is wedge-shaped with the base fashioned into the condyle for the mandibular ramus. Its posterior face to the apex, is articulated with the large squamosal, which rises towards the parietal bone. The distal part of the quadrate is grooved anteriorly, and each edge sends a process forwards. The internal is short, and articulates with the pterygoid. The external is the long horizontal part of the bone already mentioned. It is compressed, and at the end is acuminate. Although the malar bone is out of place in the specimen described, examination of the skull of the *Clepsydrops natalis,* where it is preserved in position, shows that this horizontal ramus of the quadrate is nothing more than the zygomatic process of the squamosal bone of the Mammalia, forming with the malar bone the zygomatic arch. *In the Pelycosauria there is but one posterior lateral arch,* as is demonstrated by many specimens ; hence, we have here a reptile with a zygomatic arch attached to the distal extremity of the quadrate bone.

Important results follow this determination. We have seen that, with Peters, we need no longer look to the auricular chain of ossicles, and especially to the incus, to find the homologue of the os quadratum of the Vertebrata below the Mammalia. According to Albrecht *the os quadratum is the homologue of the zygomatic portion of the squamosal bone.* If this be true, in the process of specialization of the reptiles, the anterior or zygomatic portion of the quadrate has been lost or separated as a quadratojugal bone, and the condylar portion extended, until it has reached the extreme length we observe in snakes. This determination of the character of the quadrate bone in the Theromorphous Reptilia is confirmatory of the theory broached by Albrecht.* Among many propositions novel to the science of osteology, none has been more unexpected than his assertion that the quadrate bone is the homologue of the zygomatic and glenoid portion of the squamosal bone of Mammalia. This is in contradiction to the view held by many comparative anatomists from the day of Reichert to the present time.

I made a study of these arches several years ago, which is published in the Proceedings of the American Association Adv. Science, Vol. xix, p. 18. Accepting the prevailing view that the quadrate bone is one of the auditory ossicles, I naturally homologized the superior arch of the reptilian skull, which articulates with the squamosal proper, with the zygomatic arch, and looked upon the quadratojugal arch as an additional structure, connected with the peculiar development of the supposed incus.

* Sur la valeur morphologique de l'articulation mandibulaire et des osselets de l'oreille, etc , Bruxelles, Mayolez, 1883.

Should Albrecht's determination of the homology of the quadrate bone prove to be correct, the quadratojugal arch is the zygomatic, and the superior arch becomes the accessory one. This being admitted, the Lacertilia cannot be said to have a zygomatic arch, and the Theromorpha do not possess their postorbito-squamosal arch; the diversity between the two orders being thus greater than has been supposed.

THE ARTICULATION OF THE RIBS IN EMBOLOPHORUS.—The ribs of the Theromorpha are two-headed. While the tubercular articulation has the usual position at the extremity of the diapophysis, the capitular is not distinctly, or is but partially indicated, on the anterior edge of the centrum, in Clepsydrops and Dimetrodon. In Embolophorus, as I showed in 1869, the capitular articulation is distinctly to the intercentrum. A second and larger species of that genus, recently come to hand, displays this character in a striking degree, since the intercentrum possesses on each side a short process with a concave articular facet for the head of the ribs. From the slight corresponding contact with the intercentrum seen in Dimetrodon and other genera, there can be little doubt that this is the true homology of the ribs in the order Theromorpha.

The consequence follows from this determination, that the ribs of this order are intercentral and not central elements, and that they do not therefore belong to the true vertebræ, thus agreeing with the chevron bones, with which they are homologous.

It is also true that this type of rib-articulation *approximates closely that of the Mammalia,* where the capitular articulation is in a fossa excavated from two adjacent vertebræ. This is what would result if the intercentrum were removed from a Theromorph reptile, and the head of the rib allowed to rest in the fissure between the centra left by the removal. It is well known that the double rib articulation of the other reptilian orders which possess it, viz.: Ichthyopterygia, Crocodilia, Dinosauria and Pterosauria, and in the birds, is different, the capitular connection being below the tubercular, on the centrum. Whether the capitular articulations and the ribs in these orders are homologous with those of the Theromorpha, remains to be ascertained,

THE ORIGIN OF THE MAMMALIA.—The relation of the characters of the Pelycosaurian suborder of the Theromorpha to those of the Mammalia may now be seen to be very important. I give a synopsis of the characters of these divisions parallel with those of the Batrachia contemporary with them, in order to give a clear idea of the reasons for believing that *the Mammalia are the descendants of the Pelycosauria.*

The following table shows that the Mammalia agree with the Batrachia in two and part of another character; with the Pelycosauria in six characters, and with other Reptilia in two characters. The Pelycosauria agree with the Batrachia in two and in parts of two other characters, and with other Reptilia in three characters, two of which (Nos. 2 and 3) are of prime importance. Of the characters in which the Pelycosauria agree

	Batrachia.	Pelycosauria.	Other Reptilia.	Mammalia.
1. Basicranial axis,	Unossified and with a parasphenoid.	Ossified ; no parasphenoid.	Ossified ; no parasphenoid.	Ossified ; no parasphenoid.
2. Occipital condyle,	Two.	One.	One.	Two.
3. Quadrate bone,	Separate.	Separate.	Separate.	"Coössified with squamosal."—(Albrecht.)
4. Postorbitosquamosal arch,	Present (in Permian forms).	Wanting.	Present (generally).	Wanting.
5. Coracoid bone,	Small, coössified.	Small, coössified.	Large, distinct.	Small, coössified.
6. Ribs,	Diapophysial.	Intercentral.	Diapophysial and central (in position).	Intercentral.
7. Pelvis,	Without obturator fora men.	Without obturator foramen.	With obturator foramen.	With obturator foramen.
8. Posterior foot,	Intermedium, tibiale, fibulare and centrale distinct.	Tibiale, fibulare and centrale distinct ; intermedium united with tibiale.	Intermedium, and centrale not distinct ; tibiale and fibulare generally not distinct.	Tibiale, fibulare and centrale distinct ; intermedium united with tibiale.
9. Humerus,	With condyles.	With condyles and epicondylar foramen.	No epicondylar fora men rarely condyles.;	Condyles ; frequently epicondylar foramen.

with the Mammalia, two are of first class importance (Nos. 1 and 5); three are of great but unascertained degree of importance (Nos. 4, 6 and 8), and one (No. 9) is of less importance. The two characters (Nos. 2 and 5) in which the Mammalia agree with the Batrachia, are of high importance, but one of them is also a point in which the Pelycosauria agree with both (structure of the coracoid bone, No. 5). There is but one character, the distinctness of the quadrate bone, in which the Batrachia agree with the Reptilia in general.

The preceding comparison renders it extremely probable that the Mammalia are descended from the Pelycosaurian Reptilia. The usual definitions have been invalidated, excepting that of the occipital condyles, but even this is not so absolute a character as has been supposed. In the gecko lizard, Uroplates, the occipital condyle is represented by the exoccipital pieces only, the basioccipital element being omitted nearly as in the Mammalia. Professors Huxley and Parker have declared it as most probable that the true ancestor of the Mammalia have been the Batrachia. It is evident that the Pelycosauria are in various respects the most Batrachian of the Reptilia, for they agree with them in three and parts of two other characters of the nine above enumerated. One of the latter is the structure of the posterior foot, which displays much less modification from the Batrachian type than that of the ordinary Reptilia.

The first evidence of the resemblance of the Pelycosauria to the Mammalia was empirical and not conclusive. This consisted in the characters derived from the long bones of the limbs. Professor Owen first called attention to this resemblance in the genus Cynodraco, which is a Theromorph reptile. I next pointed out corresponding peculiarities in the humeri of the American Theromorphs. I subsequently showed the resemblance between the pelvis of the Pelycosaur division, and that of the Monotremata. This was followed by a demonstration of the resemblance between the coracoid of the Pelycosauria and the Mammalia of the Monotrematous order, especially the family of the Platypodidæ. The present article now adds that the structure of the posterior foot approaches near to that of the Monotremata; and that the os quadratum and the ribs are essentially like the corresponding parts in all the Mammalia. The last three points are essential and fundamental. The three great distinctions between the Mammalia and Reptilia in the skeleton are: (1) in the quadrate bone; (2) in the coracoid bone, and (3) in the occipital condyle. Of these the last only now remains, and this is weakened by the presence of the Mammalian type in the geckotian lizard already referred to. The only interruption in the series which has not yet been overcome is in the columella auris. No reptile is yet known where that element is divided into incus, orbicularis, and stapes, as in the Mammalia and some Batrachia (according to Albrecht). Of course the above comparison with the Monotremata considers the latter order in its proper ordinal definitions, and not in its special subordinate modifications now existing, the Platytidæ and Tachyglossidæ. Montremata dentition like that of the known Jurassic and Triassic Mammalia will doubtless yet be discovered in beds of those ages.

As this paper goes to press, the interesting announcement made at the meeting of the British Association for the advancement of science at Montreal may be referred to. Mr. Caldwell, the holder of the Balfour scholarship, telegraphs that he has discovered that the *Platypus anatinus* is oviparous, and that the egg is meroblastic. This confirms the hypothesis of descent from reptilian ancestors rather than Batrachian. Haeckel gives the segmentation as meroblastic, Studien zur Gastræa Theorie, Jena, 1877, p. 65.

Note on the Tarsus.—I am just in receipt of an MS. from Dr. Baur, of New Haven, in which he presents an identification of the "internal navicular" bone of some rodents, and which probably existed in the ungulate genera Pantolambda and Bathmodon. He identifies it with the tibiale, and denies that the astragalus includes that element, but that it consists wholly of the intermedium. This identification will also apply, though Dr. Baur in his manuscript does not make it, to the element which supports the spur in the known Monotremata. It will also explain the nature of the element which occupies the same position in the foot of the Pelycosauria above described. The arrangement in this order of reptiles confirms the conclusion reached by Dr. Baur, since the questionable element is here in direct contact with the tibial facet of the astragalus.

Note on Phylogeny of the Vertebrata.—As my researches have now, as I believe, disclosed the ancestry of the Mammals,* the birds,† the reptiles, and the true fishes,‡ or Hyopomata, I give the following phylogentic diagram illustrating the same. This will only include the leading divisions. The special phylogenies of the Batrachia ‖ and Reptilia,§ and some of the Mammalia ¶ have been already given.

The Mammalia have been traced to the Theromorphous reptiles through the Monotremata. The birds, some of them at least, appear to have been derived from the Dinosaurian reptiles. The Reptilia in their primary representative order, the Theromorpha, have been probably derived from the Rhachitomous Batrachia. The Batrachia have originated from the subclass of fishes, the Dipnoi,‡ though not from any known form. I have shown that the true fishes or Hyopomata have descended from an order of sharks,‡ the Ichthyotomi, which possess characters of the Dipnoi also. The origin of the sharks remains entirely obscure, as does also that of the Marsipobranchi. Dohrn ** believes the latter class to have acquired its

* American Naturalist 1884, p. 1136.

† Proceedings Academy Philadelphia, 1867, 234.

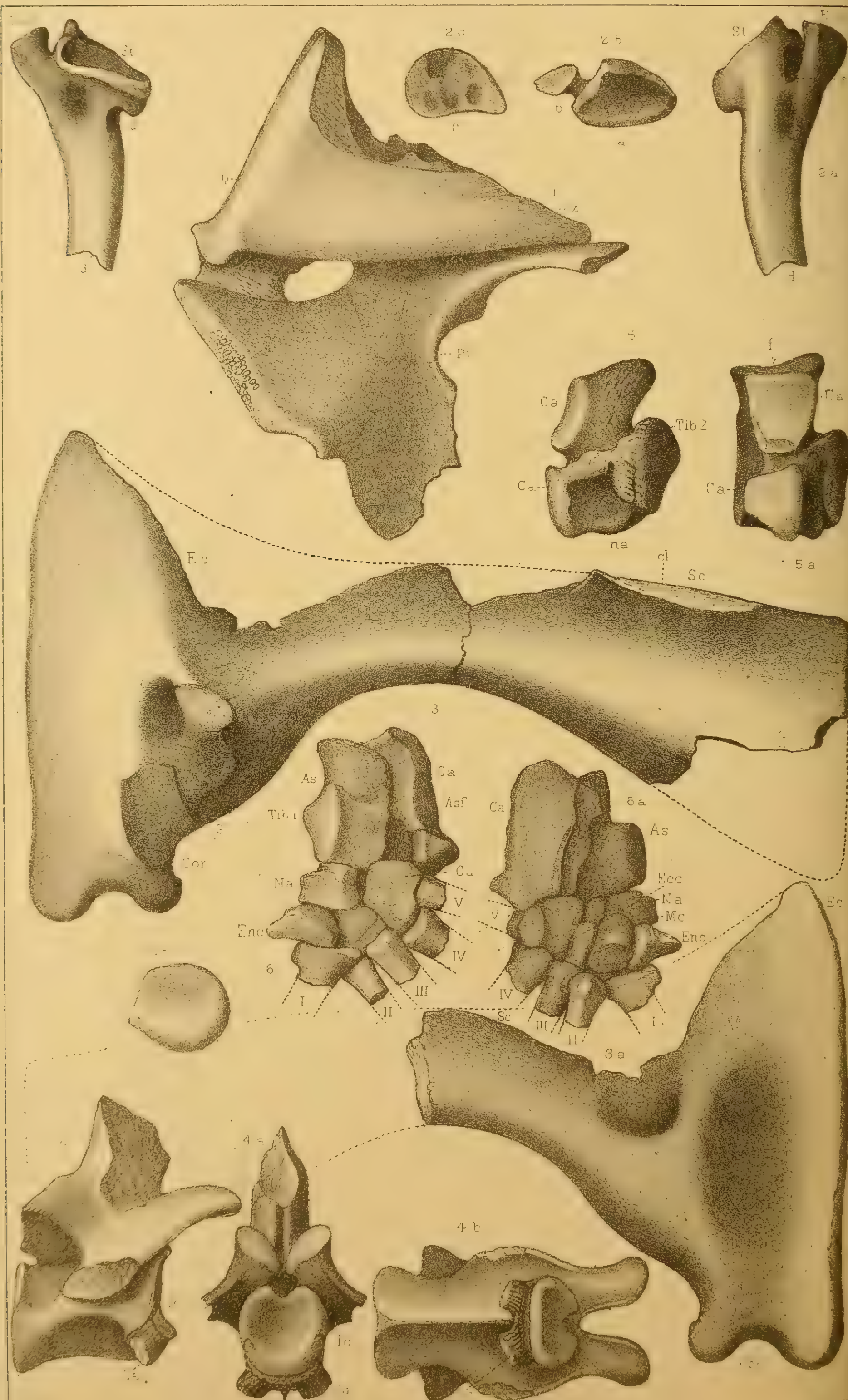
‡ Proceedings American Philosophical Society, 1884, p. 585.

‖ American Naturalist, 1884, p. 27,

§ Proceedings American Association for the Advancement of Science, xix, 1871, 233.

¶ Proceedings American Philosophical Society, 1882, 447; American Naturalist, 1884, p. 261 and 1121. Report U. S. Geol. Survey W. of 100th Mer., G. M. Wheeler, 1877, iv, ii, p. 282.

** Der Ursprung der Wirbelthiere u. d. Princip des Functionwechsels, von Anton Dohrn, Leipsic, 1875, p. 32.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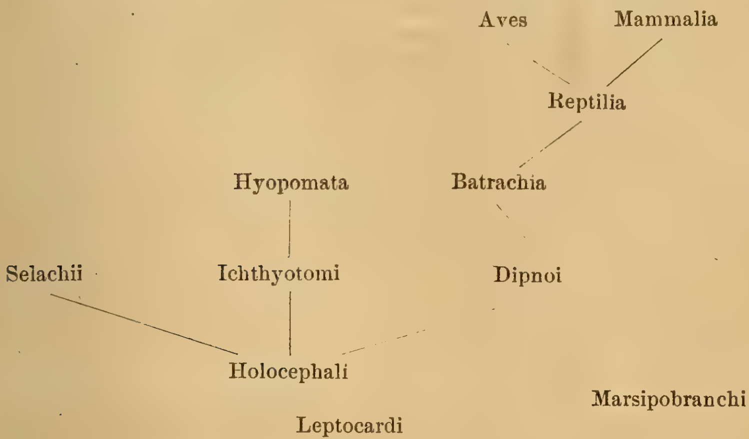
present character by a process of degeneration. The origin of the Vertebrata is as yet entirely unknown, Kowalevsky deriving them from the Tunicata, and Semper from the Annelida.



EXPLANATION OF PLATE.

Fig. 1. *Clepsydrops leptocephalus* Cope, right quadrate bone (Q) with condyle and zygomatic process (*z*) from the right, or external side. *Pt,* pterygoid bone of same side displaced so as to be in plane of quadrate, and to be seen from inferior side. One-half natural size.

Fig. 2. Columella auris of the individual of *Clepsydrops leptocephalus* represented in fig. 1; internal side. Fig. 2*a* external side; 2*b* proximal extremity; 2*c* distal extremity; *s*, head of stapes; Ecol. epicolumella; *d*, distal articular surface, especially represented in fig. 2*c*. All figures are half natural size, excepting 2*c*, which is natural size.

Fig. 3. Left half scapular arch of a Pelycosaurian, less clavicle and episternum, one-half natural size. *sc*, scapula; *cl*, facet for clavicle; *cor*, coracoid; *ec*, epicoracoid; *s*, open suture between coracoid and epicoracoid, indicating the immaturity of the animal.

Fig. 4. Dorsal vertebra of a species of Embolophorus, one-half natural size; right side; *a*, from front; *b*, from below; *ic*, intercentrum; *ca*, capitular rib articulation.

Fig. 5. Astragalus of individual figured in fig. 4, one-half natural size; from below. *ca*, *ca*, facets for calcaneum; *na*, do. for navicular; *tib*. 2, do. for bone of spur, or os tibiale. 5*a*, same bone from external or calcaneal border; *f*, fibular facet. 5*b*, same bone, proximal or fibular extremity.

Fig. 6. Left posterior foot of *Clepsydrops natalis* Cope, superior side, and 6*a*, inferior (plantar) side, two-thirds natural size. *as*, astragalus; *ca*, calcaneum; *na*, navicular bone; *cu*, cuboid; *euc*, *mc* and *ecc*, entocuneïform, mesocuneïform and ectocuneïform bones, respectively. I, II, III, IV, V, metatarsals. *Tib* 1, Probable tibial facet. In this specimen the calcaneum is displaced; being turned backwards, so as to present its two astragalar facets (*asf*) anteriorly.

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